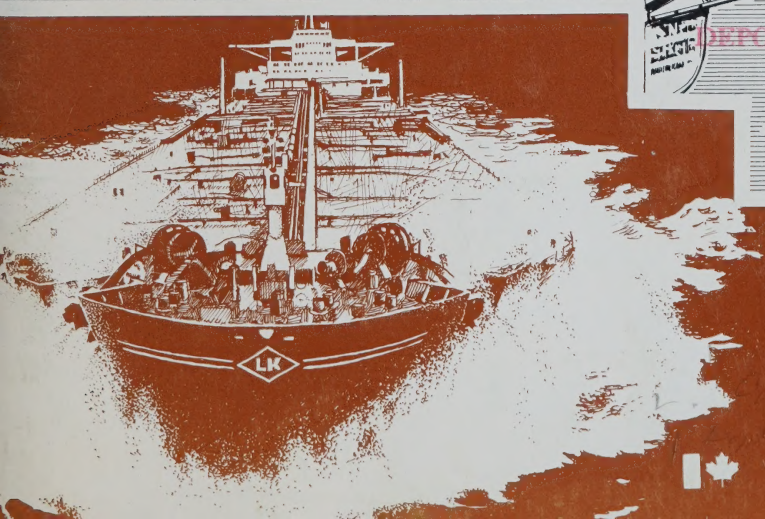
energy update

Report EI 79-2



1978

Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

energy update

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Copies of this booklet are available
on request from Energy Communications Division
Department of Energy, Mines and Resources,
Ottawa, Ontario K1A 0E4

Cat. No. M23-13/79-2
ISBN 0-662-10468-4

Published under the authority of
the Honourable Alastair Gillespie,
Minister of Energy, Mines and Resources,
Government of Canada

energy overview

THE WORLD SITUATION

A short term surplus of oil in world markets through much of 1978 did not conceal the potential seriousness of the underlying energy problem. The world continues to rely on oil to meet growing energy requirements without any assurance that sufficient oil will continue to be available.

The world's reliance on a few major sources poses two threats. In the not-so-distant future, and as early as the mid-1980's, serious problems could occur if total demand outstrips production. More immediately, the stability of supply is highly sensitive to interrupted production from any one source. Collapse of the government in Iran, the world's second largest exporter of oil, occasioned a drastic decline in Iranian oil production in November, 1978, with seriously disruptive effects on supplies to Western nations. Canada was obtaining 19 per cent of its oil imports from Iran before production was shut off.

Without either very large new discoveries of accessible oil, or a major shift to alternative sources of energy, or both, world energy supply may well be inadequate to satisfy demand in 1990. The fact that a substantial share of remaining proven oil reserves are in one country -- Saudi Arabia -- makes the situation all the more precarious. It is possible that the non-Communist world could find itself relying extensively on Saudi Arabia's willingness and ability to multiply its oil exports.

There was encouraging progress in oil development in Mexico in 1978, with a prospect of further shifting North American reliance away from Middle Eastern sources. Canada sought assurances that it would be able to obtain part of its oil import requirements from Mexico. Another potentially important event was the opening of China to the West. It is still unknown whether the industrialization of China will make a positive net contribution to the world oil situation.

The energy supply situation continues to have a serious economic impact on many countries. While international prices did not rise throughout 1978, there was a sharp reminder of underlying realities at the end of the year, when the Organization of Petroleum Exporting Countries announced a further price increase of 14,5 per cent to be phased in throughout 1979. Weakness of the U.S. dollar was partly caused by the high cost to the United States of importing almost half of its oil requirements. Some relief was obtained, however, as Alaskan oil flowed into the southern U.S. Another encouraging sign was the passage of the U.S. National Energy Act, including a number of features which will help reduce U.S. oil import demands. The Act's natural gas pricing provisions also created the conditions for progress on the planned Alaska gas pipeline system, much of which will run through Canada.

Many of the developing nations, for their part, are finding it nearly impossible to improve their standards of living because they have to import energy at today's high prices. Consequently, the energy problem and its political and economic implications remain priority issues among Canada's partners in the western world. This was emphasized at an economic summit meeting in Bonn, in which Canada participated.

Under the cooperative framework of the International Energy Agency, Canada has committed itself to participation in an emergency oil sharing system. This would reduce the impact of oil supply disruption on individual nations. The first full-scale simulated test of the system was conducted in 1978.

Solution of the longer term and more profound underlying problem requires a similar commitment to international cooperation. In coordination with the policies of its IEA partners, Canada has adopted a strategy which emphasizes a decrease in growth of energy demand, a shift to sources of energy that are viable alternatives to oil and a long term goal of self-reliance.

ENERGY IN CANADA

Owing to severe climate, long distances and a high standard of living in an industrialized society, Canada is one of the highest consumers of energy per capita in the world. In 1978 Canada's total energy consumption increased by an estimated 3,5 percent over 1977, less than the growth rate of the 1960s, but still sizeable.

Until recently, Canada has had access to abundant and relatively inexpensive supplies of energy. However, in the 1970s, accessible "light" oil reserves have been declining, and we have had to look increasingly to higher cost resources -- oil sands, remote hydro-electric sites, the potential of forest wastes and other renewable sources. Canada faces a considerable challenge to develop such energy resources as the Athabasca oil sands without undue impact on the natural and social environment. The huge Syncrude plant is likely to be the forerunner of many more developments.

In order to encourage development of these more costly sources, stimulate exploration for new resources, and encourage conservation, the federal government, in consultation with the provinces, has been gradually increasing the domestic price of oil toward the international price. Natural gas prices have been kept in an appropriate competitive relationship with oil.

In 1978, Canada imported 105 000 cubic metres of oil per day, a 9,1 per cent reduction in imports compared with the previous year. However, because of the lower Canadian dollar exchange rate, the 1978 oil deficit of $1,428 million was higher than the previous year, and had a significant effect on the balance of trade. If continuing strong action is not taken, import dependence and costs could rise sharply in the 1980s. As part of its energy strategy, the federal government is committed to hold oil imports in 1985 to one-third of oil demand, or 127 000 cubic metres (800 000 barrels) per day.

Limitation of Canada's dependence on foreign oil can be achieved through conservation efforts and development of other resources within the country. One important challenge, which became more apparent in 1978, is to make more Canadian natural gas available in areas of Eastern Canada now heavily dependent on insecure imported oil.

Conservation efforts are being made in the transportation, industry, government and residential sectors. The IEA Sub-Group on Energy Conservation has stated that Canada has "enacted essentially sound conservation programmes, particularly in the residential/commercial sector". The federal government's goal is to hold the growth in energy demand to 3,5 per cent per year or less. The conservation program includes new building codes, insulation grants, energy audits for business and industry, information programs, fleet performance standards for passenger

cars, and energy labelling of consumer products. Effective conservation of energy requires awareness, effort and investment on the part of government, business, industry, consumers and property owners.

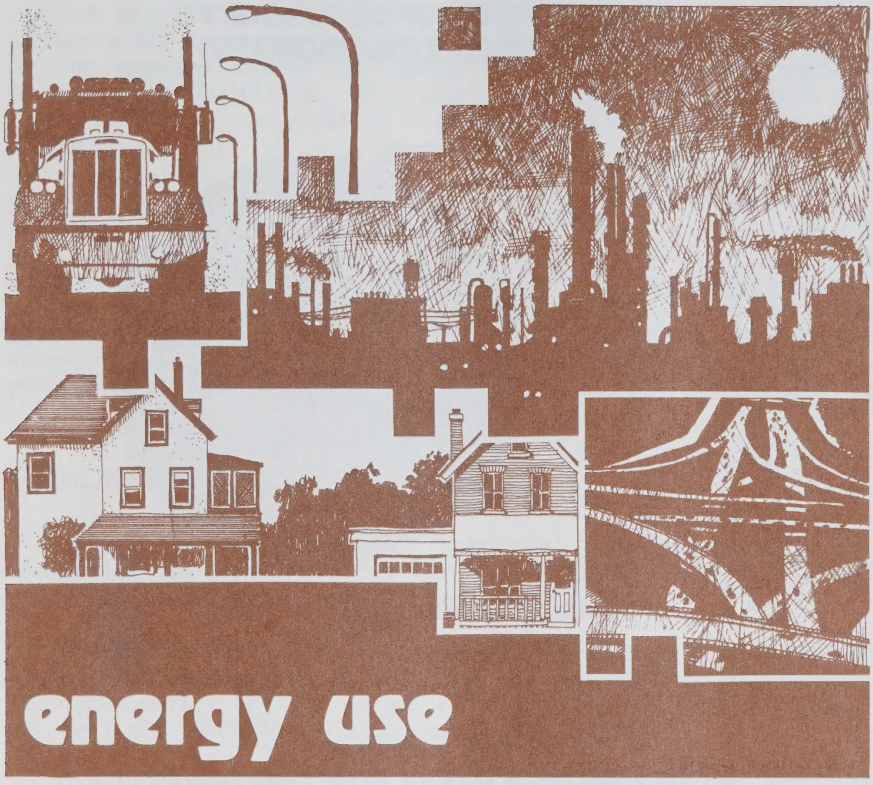
The energy situation is closely inter-related with a number of economic issues. These include the country's balance of trade, competitiveness in international markets, the capital requirements of necessary energy development, the employment generation of energy development or energy conservation, the relationship of energy costs to inflation, and the difficult balance to be achieved between reducing energy demand and needed economic growth.

While energy costs are still relatively low it is the ideal time to make capital investments for improving energy efficiency in industry through conservation measures and more advanced, energy efficient equipment. This can make an important contribution to manufacturing in the difficult, emerging world of the 1980s.

Capital expenditures on energy have been projected at $180 billion ($1977) over the period 1977-1990. It is estimated that capital expenditures will remain high enough to be a major source of growth for the economy over the next decade but not so high as to impose unmanageable strains on the economy. A balancing of the capital needs of the energy industries with other capital needs of the economy remains a matter of high priority.

The growth in total energy demand is often closely related to overall economic growth. The goal of limiting the growth in total energy demand to 3,5 per cent per year must be combined with the need for a continuing high rate of economic activity and job creation. Limiting Canada's importation of oil and its growth in energy demand, on the one hand, and increasing employment generation and manufacturing exports, on the other, are both high priorities. Balancing these needs presents the country with a major challenge.

It appears that a structural change in the economy may already have started (the rate of growth of energy consumption has been lower than the rate of growth of GNP for the past several years). However, much remains to be done to achieve more energy-efficient means of production if Canada is to remain competitive in world markets.



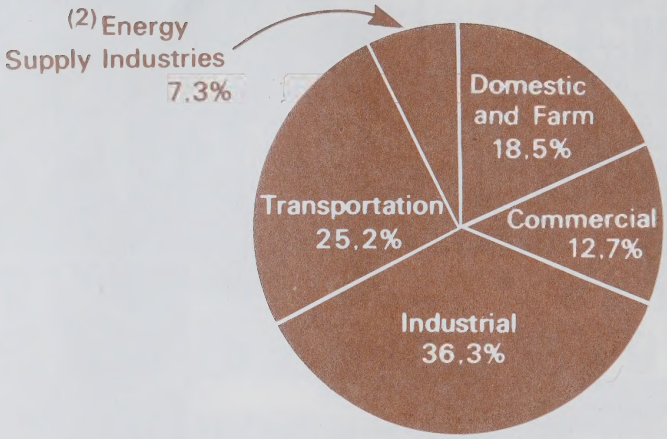
ENERGY CONSUMPTION

Canada's rate of energy consumption, on a per capita basis, is one of the world's highest. Preliminary estimates indicate that in 1978 Canadians increased their energy consumption by 3,5 per cent over 1977. The increase in 1977 was 2,8 per cent.

The rates of growth and overall consumption figures show two general trends. Canadians continue to use more and more of all types of energy and fuels. However, this rate of growth, for a variety of reasons, is decreasing and there is an emerging trend towards a slower rate of growth in consumption of oil. With strong efforts in a number of areas by governments, industry and individuals, this trend could continue.

The growth of energy demand has slowed. Between 1960 and 1975, total Canadian energy demand grew at an average annual rate of 5,1 per cent. Since 1975 it has been between 2,8 per cent and 3,7 per cent.

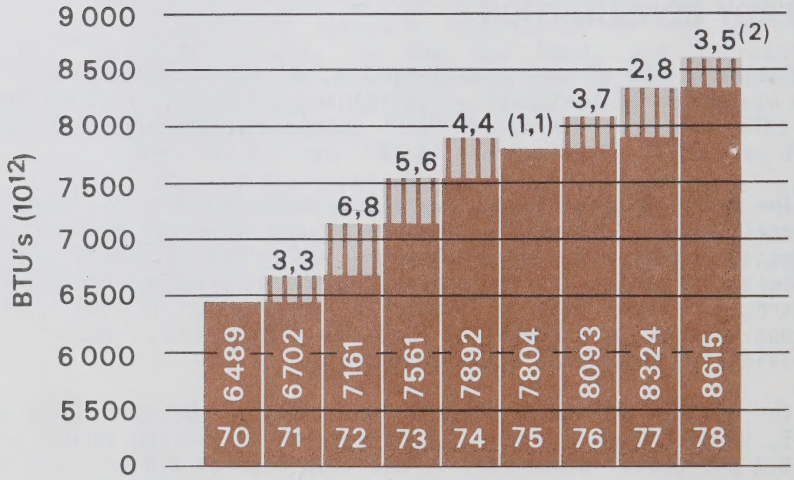
CONSUMPTION OF SECONDARY ENERGY (INCLUDING BIOMASS)



(1) Statistics Canada, 1976

(2) including pipelines

TOTAL ENERGY CONSUMPTION RATES FOR THE 1970'S



Percentage of increase over previous year. (() indicates decrease)

(1) Excluding biomass which, in 1977, amounted to a further 245 BTU's (10^{12})

(2) Preliminary values

This results partly from the slower growth of the economy as a whole, price increases and the fact that there has been a shift in the economy toward less energy intensive activities, such as service type industries. The impact of higher energy prices and specific energy conservation measures is also beginning to take effect.

USERS

The largest consumer of energy in Canada is industry, accounting for 36,3 per cent of the energy used in 1976. Transportation used 25,2 per cent, homes and farms 18,5 per cent, commercial enterprises 12,7 per cent, and the energy supply industries 7,3 per cent.

REGIONAL DIFFERENCES

Differences in climate and industrial structure account for the varied use of energy from province to province, both in terms of overall consumption and on a per capita basis.

In 1978, Ontario used 35,3 per cent of the energy consumed in Canada, followed by Quebec with 26,4 per cent and the Prairies at 19,5 per cent. British Columbia and the Territories used 10,9 per cent and the Atlantic Provinces 7,9 per cent.

Alberta had the highest per capita consumption and the Atlantic provinces had the lowest. British Columbia, Manitoba, Ontario, Saskatchewan and Quebec had very similar per capita rates of consumption.

SOURCES OF ENERGY

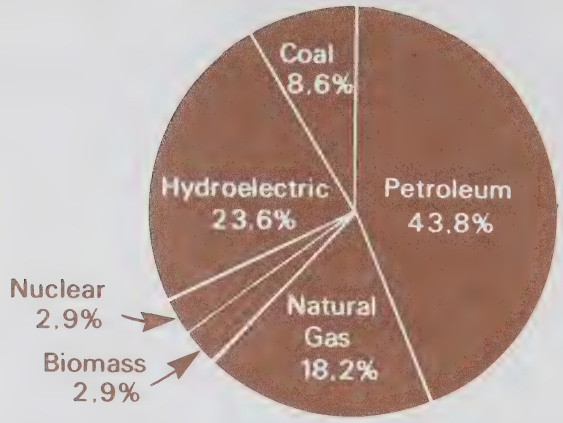
In 1978 there was a continued reliance on oil as the major source of primary energy, followed by hydro-electric, natural gas, coal and nuclear sources.

These energy resources are located in the different regions of the country as shown in the following maps.

This distribution of resources has an obvious impact on the type of energy source used in each province. In Alberta, Canada's largest oil and gas producer, 49,6 per cent of total primary energy consumption is in the form of natural gas. The Atlantic provinces, which have fewer energy resources at this time are heavily dependent on imported oil which accounts for more than 82,1 per cent of their total consumption. British

Columbia and Quebec, each with extensive hydro installations, obtained 20,4 per cent and 22,9 per cent of their total energy from hydro electricity. Ontario, Manitoba and Saskatchewan are more diversified with respect to their energy consumption.

SOURCES OF PRIMARY ENERGY



(1) 1977 EMR estimates

Consumer Prices

Following an international trend, Canadians paid more in 1978 for all types of energy. However, in most parts of the country, they still paid less than residents of other countries.

In order to promote conservation and to finance exploration and development of non-conventional and remote resources, an important target of An Energy Strategy for Canada is to move domestic oil prices toward international levels and to increase prices of natural gas to an appropriate competitive relationship with oil.

At present, federal subsidies, financed by export charge revenues and a 7¢ per gallon excise tax on non-business use of gasoline protect consumers in Quebec and the Atlantic provinces from world prices for the imported oil consumed in these areas.

Higher domestic prices can stimulate increased exploration for costlier Canadian resources such as Arctic oil and the development of the oil sands and heavy oils. The gradual increase in consumer prices can help Canadians adjust to more expensive energy as conventional sources become more scarce.

The following tables compare Canadian consumer prices for energy with international prices, the cost of other essential commodities, and show comparitive costs within Canada.

PRICES IN CANADIAN DOLLARS PER IMPERIAL GALLON
OCTOBER 1978

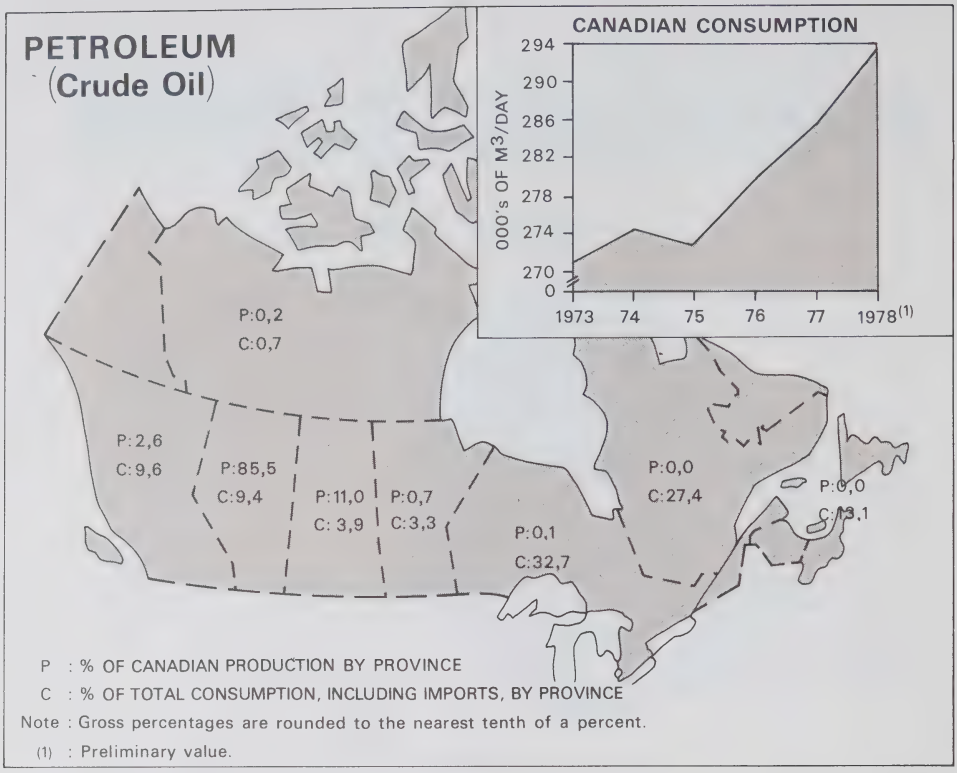
	Heating Oil (including all taxes)	Regular Gasoline (taxes in brackets)
France (Paris)	0.98	2.70 (1.66)
Italy (Average)	N/A	3.05 (2.20
Sweden	0.81[1]	2.33 (1.31)[2]
Switzerland (Zurich)	0.77	3.17 (1.85)
U.K. (London)	0.85	1.68 (0.87)
U.S.A. (New York City)	0.69	0.93 (0.24)
W. Germany (Average)	N/A	2.42 (1.18)
Canada (Average)	0.61	0.95 (0.31)[3]

[1]Stockholm
[2]Average
[3]Includes Federal and Provincial Taxes

CHANGES IN PRICES

	1950 (cents)	1978 Actual (cents)	Expressed in 1950 buying power (cents)
Heating oil (per gallon)	18	56	19
Natural gas (per thousand cubic feet)	93	248	85
Electricity (per 100 kilowatt-hour)	114	308	105
Motor gasoline (per gallon)	41	93	32
Milk (per quart homogenized)	17	61	21
Bread (per loaf)	13	51	17
Eggs (per dozen, Grade A large)	56	94	32

Source: Prices based on Statistics Canada Consumer Price Indexes and EMR estimates.

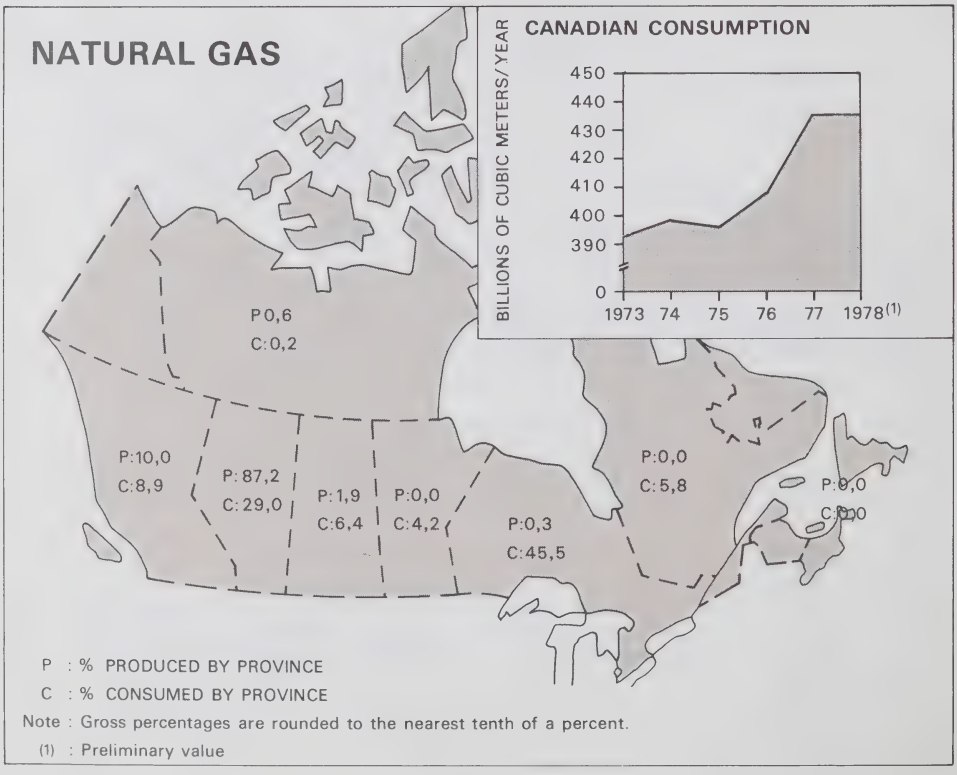


P : % OF CANADIAN PRODUCTION BY PROVINCE

C : % OF TOTAL CONSUMPTION, INCLUDING IMPORTS, BY PROVINCE

Note : Gross percentages are rounded to the nearest tenth of a percent.

(1) : Preliminary value.

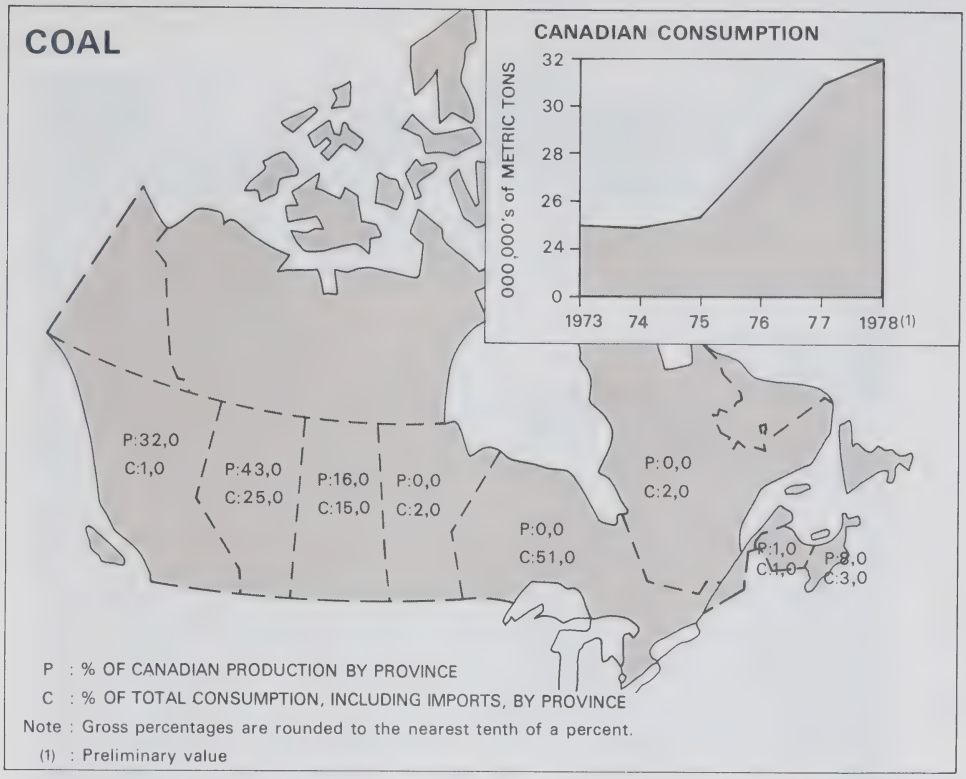


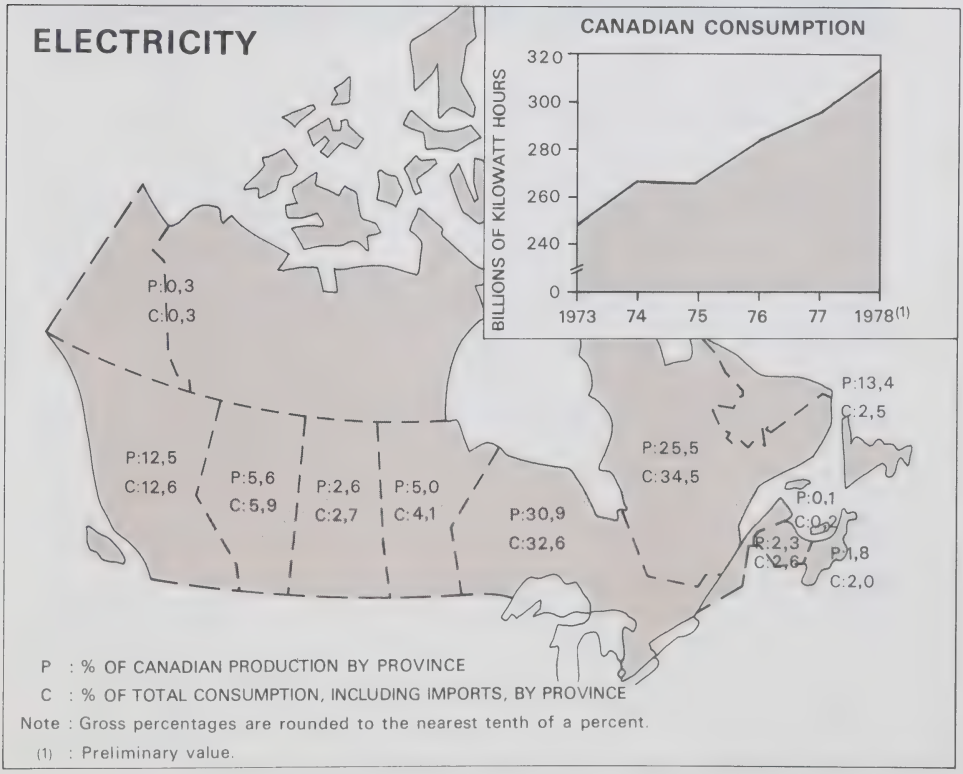
P : % PRODUCED BY PROVINCE

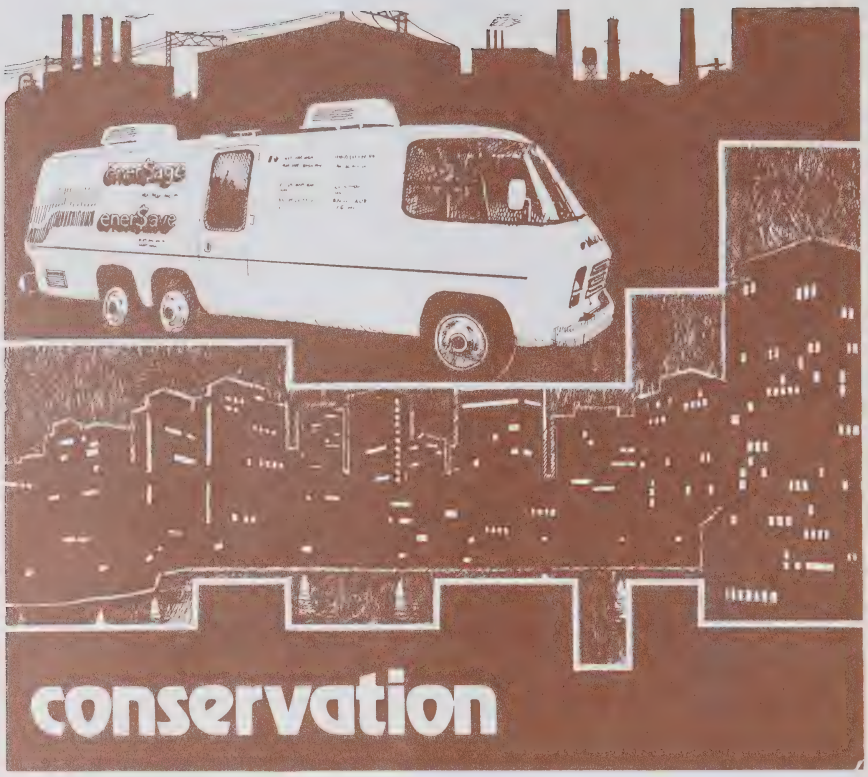
C : % CONSUMED BY PROVINCE

Note : Gross percentages are rounded to the nearest tenth of a percent.

(1) : Preliminary value


COAL
CANADIAN CONSUMPTION
000,000's of METRIC TONS
32
30
28
26
24
0
1973
74
75
76
77
1978(1)
P:32,0
C:1,0
P:43,0
C:25,0
P:16,0
C:15,0
P:0,0
C:2,0
P:0,0
C:51,0
P:0,0
C:2,0
P:1,0
C:1,0
P:0,0
C:3,0
P : % OF CANADIAN PRODUCTION BY PROVINCE
C : % OF TOTAL CONSUMPTION, INCLUDING IMPORTS, BY PROVINCE
Note : Gross percentages are rounded to the nearest tenth of a percent.
(1) : Preliminary value


ELECTRICITY
CANADIAN CONSUMPTION
BILLIONS OF KILOWATT HOURS
320
300
280
260
240
0
1973
74
75
76
77
1978(1)
P:0,3
C:0,3
P:12,5
C:12,6
P:5,6
C:5,9
P:2,6
C:2,7
P:5,0
C:4,1
P:30,9
C:32,6
P:25,5
C:34,5
P:13,4
C:2,5
P:0,1
C:0,2
P:2,3
C:2,6
P:1,8
C:2,0
P : % OF CANADIAN PRODUCTION BY PROVINCE
C : % OF TOTAL CONSUMPTION, INCLUDING IMPORTS, BY PROVINCE
Note : Gross percentages are rounded to the nearest tenth of a percent.
(1) : Preliminary value.



NEED

Since gasoline and oil are readily available today, the casual observer may not see any reason for concern about a continuing flow of oil in the years to come. It is important to realize that even at a comparatively low rate of growth in energy demand, very large new sources of supply are needed to satisfy the world's already enormous appetite for oil and to offset declining oil reserves.

And the world will increasingly be competing for the major remaining Middle Eastern source - the oil reserves of Saudi Arabia. To cover all requirements, this one nation might be asked to expand greatly its already large daily oil production. It simply might not be possible, for either political or geological reasons, to get enough oil from this one source. Late in 1978, the disruption of Iran's oil supplies underscored the weaknesses in the current world oil supply system.

GOALS

Efficient use of energy must extend beyond oil to natural gas, coal and electricity because increasing prices for all forms of energy are beginning to affect seriously the disposable income of individuals and the profitability of firms. These higher prices are caused by increasing cost of domestic projects for new supplies of energy, as well as the higher cost of imported oil.

The federal government's goal is to reduce the average rate of growth of energy use in Canada, over the next 10 years to less than 3,5 per cent from the average growth rate of about 5,1 per cent a year which had prevailed over the past 15 years.

Conservation of energy resources is one of the most important means of achieving some of the key goals of the Energy Strategy. Thus, if average energy demand growth rates were reduced from 3,7 per cent a year to 2 per cent per year over the period 1975 to 1990, the lower total energy demand in 1990 would be equivalent to the annual output of 11 Syncrude sized oil sand plants costing in excess of $50 billion.

Trends for oil, gas and electricity products indicate that conservation measures are taking effect.

SOME MAJOR EVENTS OF 1978

INDUSTRY

Key industrial sectors have been brought together and encouraged to develop voluntary energy conservation goals.

The federally-sponsored Energy Bus program which provides on-site computerized energy audits to industry, business and public institutions was expanded from Prince Edward Island and Nova Scotia to British Columbia, Quebec, Ontario, Saskatchewan, Newfoundland and New Brunswick. The vehicles and program are modelled after the successful project created and operated by the Province of Ontario. As a result of these audits it is estimated that an average energy cost saving of almost 20 per cent can be made by more efficient heating, cooling and lighting. For most plants, these savings require low cost applications and with more detailed analysis and higher capital expenditures, much higher savings can be realized.

BUILDINGS

The Canadian home insulation program was expanded to include all homes built up to 1945, and provides up to $350 for the cost of materials.

The development of a "Canadian Code for Energy Conservation in New Buildings" was completed in June 1978. This code contains thermal efficiency standards based on economic and technical criteria developed by the National Research Council for varying climates, defined in degree days.

Energy efficient design and the use of 'passive' solar energy through building orientation are being encouraged by the Low Energy Building Design Awards with prize money totalling $350,000. This was part of a major 1978 federal initiative in conservation and renewable energy.

New building codes have been adopted for all new federal buildings.

CONSUMER PRODUCTS

Energy labelling of refrigerators was initiated in 1978. Labelling of other products such as freezers and ranges will be introduced in 1979.

PUBLIC INFORMATION

"Enersave" home energy audits were conducted in selected communities across the country. This community program made use of local manpower with federal funding designed to reduce unemployment. It is also conducted as part of the Canadian Home Insulation Plan (CHIP) and in 1979 will be available for all Canadian residences.

The "Eneraction" program began in early February and operated through September. It was a project of the Department of Energy, Mines and Resources funded through the Federal Labour Intensive Program. It provided community conservation centres, regional resource centres, home insulation assistance and furnace efficiency testing.

More than 6 million requests for free energy conservation booklets have been filled, and vans promoting conservation continued to tour in 1978.

GOVERNMENT

A National Advisory Committee on Conservation and Renewable Energy, chaired by the Minister of Energy, Mines and Resources, was created and will be an important source of policy advice.

Provincial programs have developed rapidly in 1978. By the year end, virtually all provinces were expected to have specific energy conservation and renewable energy programs.

POLICY GOALS

Since its formulation in 1976, Canada's energy strategy has required major adjustments from the domestic oil and gas industries. Record levels of exploration and development activity have already been achieved. Over the longer term, the strategy will demand from oil consumers a major shift from their reliance on traditional sources of supply to alternative sources of oil and to alternative fuels.

Against a background of continuing decline in existing reserves of conventional crude oil, the goal of national self-reliance has the following policy implications for the oil and gas sectors:

- Limitation of oil imports, specifically to the lesser of 127 000 cubic metres a day or one-third of total national oil requirements by 1985.

- Elimination of all domestic crude oil exports, except heavy crude oils, by 1981.

- Overall reduction in the growth of domestic energy consumption to less than 3,5 per cent annually and consequent reduction in consumption of oil.

- Partial replacement of oil by natural gas and other energy sources, particularly in those areas of eastern Canada that have been wholly dependent on imported oil.

- The proving of new domestic reserves of oil and gas, including both the discovery of new reserves and the development of oil sands and heavy oil deposits.

PRODUCTION, CONSUMPTION, IMPORTS AND EXPORTS

Oil

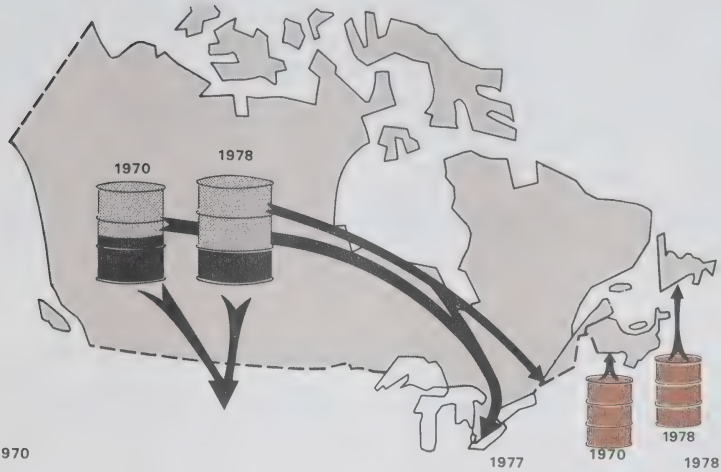
In general and on major specific fronts, the oil component of Canada's energy demand and supply relationships continued throughout 1978 to shift in the direction of our long-term energy goals.

As a result of the combined effect of consumer pricing disincentives, and strengthened conservation efforts, Canadian consumption of crude oil and natural gas liquids in 1978 was held to a growth rate of 2,4 per cent, an increase from 286 400 cubic metres per day to 293 300 cubic metres per day. This compares favourably with a growth rate of 5,25 per cent between 1973 and the end of 1977.

We moved closer to the goal of national self-reliance through a 9,1 per cent decrease in the use of imported oil, from 115 400 cubic metres per day in 1977 to 104 900 cubic metres per day in 1978. This reduction can be attributed largely to the displacement of imported crude oil by western Canadian crude in meeting the demands of Montreal area refiners. The reduction in imports is consistent with the goal set in 1976 of reducing imports to one-third of total national oil requirements.

Exports were reduced in 1978 by 6,9 per cent from 84 700 cubic metres per day in 1977 to 78 800 cubic metres per day. Crude exports dropped from 51 600 cubic metres per day in 1977 to 42 300 cubic metres per day in 1978, an average reduction of 18 per cent. The reduction continues to reflect the federal government's policy of phasing out all exports of light crude oil to the United States. However, because a more favourable future oil supply scenario began to emerge in 1978, the National Energy Board has recommended that the export limitation program be slowed to maintain licensing of exports of light crude oil at the 1978 level for three additional years and licensing of heavy crude exports on the current basis, i.e. restricted to those quantities that are surplus to the requirements of Canadian refiners.

PETROLEUM IMPORTS AND EXPORTS



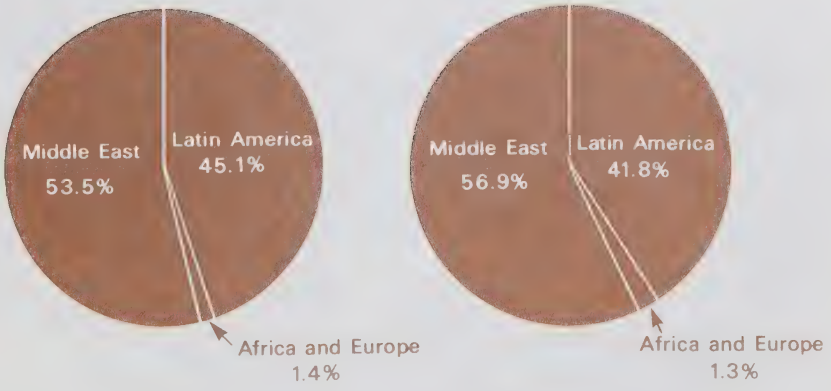
(ESTIMATED AVERAGE)

1970			1977		1978[1]	
MB/D	m^3/day		MB/D	m^3/day	MB/D	m^3/day
1 476	234 600	TOTAL CANADIAN PRODUCTION	1 607	255 400	1 577	250 600
762	121 100	IMPORTS	726	115 400	660	104 900
763	121 200	EXPORTS	533	84 700	496	78 800
1 475	234 400	CONSUMPTION	1 802	286 400	1 846	293 300

MB/D : Thousands of barrels per day. m^3/day: Cubic meters per day
Includes refined products and liquefied petroleum gases.
[1]Both imports and exports include about 14,800m^3/d(93MB/D) of exchange oil with the U.S.A.

Note: Differences between supply and disposition are due to stock changes, losses and adjustments.

SOURCES OF CANADIAN CRUDE OIL IMPORTS



(1) Excluding oil exchanged with the United States

Source: Statistics Canada

Total Canadian production of crude oil and its equivalents actually declined in 1978 by 1,9 per cent to an average level of 250 600 cubic metres per day. Conventional crude oil production declined by 2 500 cubic metres per day to 199 600 cubic metres per day while synthetic crude oil production increased by 1 400 cubic metres per day to 8 800 cubic metres per day. Production of natural gas liquids declined by 8,3 per cent to 42 100 cubic metres per day largely because of the milder winter.

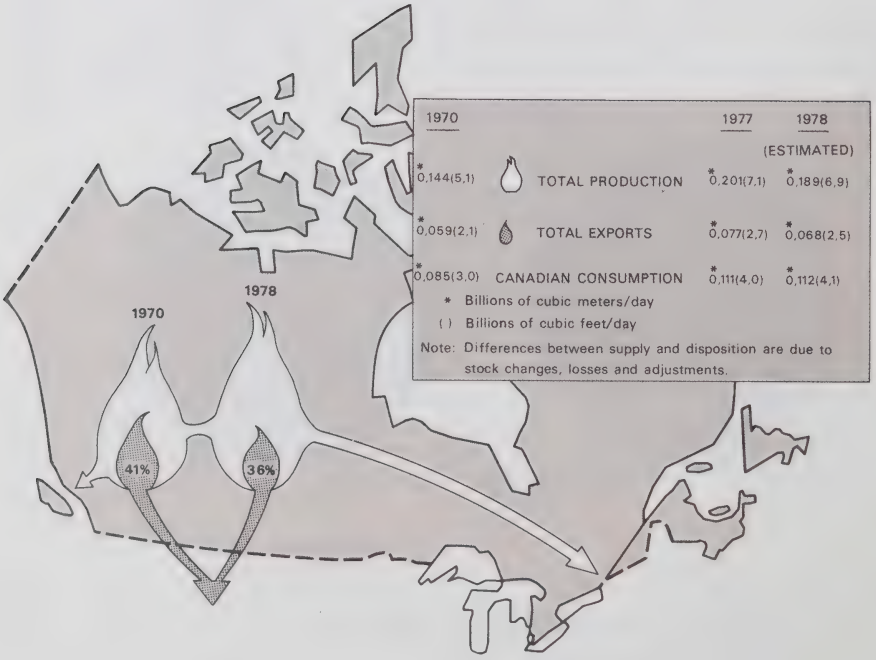
Canada remains, of course, a net importer of oil. In 1978 Canada's deficit in its foreign trade of crude oil and oil products was approximately $1,428 million. The 1977 deficit was $1,100 million.

Gas

New eastern Canadian markets for growing reserves of western gas await the extension of the pipeline distribution system east of Montreal.

Another potentially important factor in substituting domestic natural gas for imported oil is the proposed Petro-Canada project to move Arctic gas to southern markets by ice-breaking tankers.

NATURAL GAS EXPORTS



Gas sales to Canadian customers increased only marginally in 1978, to an estimated 112,1 million cubic metres per day from 111,1 million cubic metres per day. Gas sales to U.S. customers actually declined, total exports dropping from their 1977 level of 77,6 million cubic metres per day to 68,4 million cubic metres per day in 1978. 1978 did not see a repetition of emergency sales to the U.S. that were the result of a particularly severe winter of 77/78. Even so, revenue from gas exports increased from $2,092.9 million in 1977 to an estimated $2,165.1 million in 1978.

Total Canadian production declined by 5,5 per cent, from 201,1 million cubic metres per day in 1977 to 189,9 million cubic metres per day in 1978.

EXPLORATION, DISCOVERIES AND RESERVES

However effective conservation measures and fuel substitution (e.g. coal and gas for oil) might be in retarding the depletion of Canada's oil reserves, achieving our national goal of self-reliance depends ultimately on the success of the industry's efforts to develop new reserves: new reserves of oil to meet the needs of domestic refiners, and new reserves of gas for large scale displacement of imported oil. Reserves are defined as the amount of oil and gas known to be recoverable at commercial rates from proven deposits.

Net additions to our gas reserves continue to grow as new discoveries in Alberta and British Columbia outstrip annual consumption rates. The need to prove new reserves of oil is more critical. Oil reserves have been steadily declining since 1969. Production during that time has outstripped additions to reserves.

Canada's oil reserves can be increased by improving the recovery ratio of known conventional deposits, through discovery of new deposits, and by development of plants to recover oil from oil sand and heavy oil deposits.

Until 1977, there had been no major oil discovery in Canada since 1965. Thus, the discovery of oil in 1977 in the West Pembina area of central Alberta was highly significant. Exploration of the field continued unabated throughout 1978, and since the original find at least 40 more exploratory wells have encountered oil and gas in the area.

Generally, the quest for new reserves continued throughout 1978 at a peak level of activity. Oil and natural gas exploration and development expenditures for the year should exceed the 1977 record $1,222.9 million. An unprecedented 6 900 wells were drilled during 1978.

These exploration activities are a critical contribution by the oil and gas industry to Canada's energy strategy. The sustained activity levels of the last three years can be expected to continue through 1979 and can be attributed to three factors: the rise in domestic oil prices to near world levels, the promising results of expanded exploration activities, and major federal and provincial government incentives.

Because of these developments, and improved prospects for synthetic oil development, the National Energy Board, in its Canadian Oil Supply and Requirements of September 1978, concluded that the domestic oil supply outlook was somewhat better than had been forecast in its February 1977 report.

Domestic Prices

The cornerstone of Canada's energy strategy is the pricing policy for oil and natural gas. It has two elements: the movement of domestic oil prices towards world levels; the movement of domestic natural gas prices to a level that is appropriately competitive with oil.

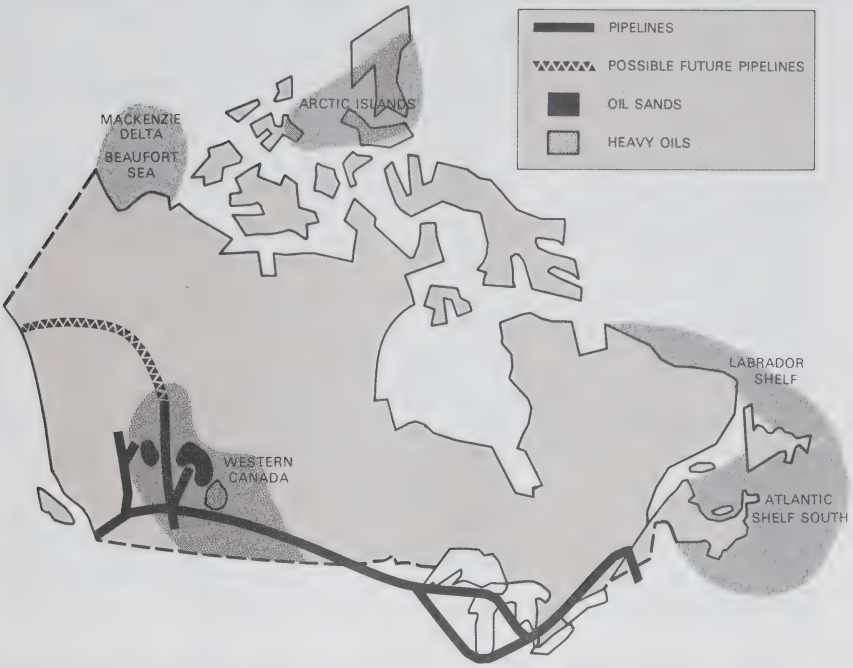
The rise in oil prices is intended simultaneously as a consumer disincentive and a producer incentive. As a consumer disincentive, its effect has been to dampen demand for petroleum products by encouraging conservation measures and the shift to alternative energy sources. As a producer incentive, its effect has been to encourage the industry to increase exploration and development activity, particularly in higher-cost resource areas and oil sands and heavy oil deposits.

Balancing consumer concern against these policy objectives, price rises have been phased to protect Canadians against the sudden and economically disruptive increases that nations wholly dependent on OPEC oil have been subjected to over the last five years. Since the federal government began regulating domestic crude oil prices in April 1974, the wellhead price has moved from $3.80 per barrel* to $12.75 as of July 1, 1978, only gradually approaching international prices. Consequently, Canadian consumers remain favoured among the consumers of western nations, still paying lower prices for gasoline and heating oil.

Current pricing policy is governed by understandings reached at the May 1977 meeting of federal and provincial Energy Ministers. The subsequent agreement between the federal and Alberta governments established a schedule of four semi-annual price rises commencing July 1 of 1977.

* NOTE - 1 barrel = 0.1589873 cubic metres

CANADA'S MAJOR OIL RESOURCE AREAS



CANADA'S MAJOR NATURAL GAS RESOURCE AREAS

The second and third increases of $1 per barrel each were implemented in 1978, the first on January 1, the second on July 1, with their effect passed on to the consumers on March 30 and August 30 respectively. The July 1 increase brought the price to $12.75 per barrel. At that time, a barrel of imported crude of the same quality landed at Montreal cost $16.

In the course of 1978 it became clear that a short-term surplus of petroleum in world markets was effectively retarding the rise in prices, particularly in the U.S. Consequently it was agreed between the federal and Alberta governments to postpone the fourth increase of $1 per barrel scheduled for January 1, 1979. It was subsequently agreed between the two governments to effect rises of $1 per barrel in July, 1979, and January 1980.

As a national policy, natural gas prices have been closely related to oil prices since 1975. The objective has been to find an appropriate relationship between the two such that growing reserves of natural gas could become a viable substitute to the consumer for oil drawn from shrinking domestic reserves and expensive foreign sources. The appropriate level must therefore be one which is sufficiently lower than oil to induce the consumer to switch. For the producer and distributor, it must be sufficiently high to encourage development of new reserves and construction of expensive distribution systems.

The Alberta and federal governments reached agreement which allowed the price of natural gas delivered to Toronto to rise to $2.00 per thousand cubic feet* on August 1, 1978. At that level, the price of natural gas is approximately 85 per cent of the heat equivalent value of crude oil.

At the 85 per cent relationship the consumer incentive is adequate to maintain gas sales in established gas market areas and allow for some conversions. However, at that level, it is not proving economically feasible for distributors to undertake expensive extensions to their transportation systems. In recognition of that fact, and of the importance to Canada's energy strategy that new markets be developed for gas, the federal and Alberta governments have agreed in principle that a market development rate be provided to distributors for a period in order to facilitate the expansion of distribution networks and sales. Details of the 1978 agreement in principle will be developed and formalized in 1979.

Export Prices and Import Compensation

While domestic buyers of Canadian crude are still shielded from the full effect of world price rises, foreign buyers of Canadian crude are subject to export charges which bring the cost

* NOTE - 1 cubic foot = .02832784 cubic metres

of Canadian crude to world levels. Export charges for crude oil and petroleum products were set in February 1979 at the following scale:

light crude oils	$6.75 per barrel
designated crude oil blends	$5.00 per barrel
designated heavy oils	$5.45 per barrel
motor gasoline	$4.75 per barrel
heavy fuel oil	$3.45 per barrel
partially processed oil	$6.40 per barrel

Revenues from these export charges are used to ensure that all Canadians are able to enjoy the preferential domestic rates. Under a program of federal assistance to areas of Canada dependent on imported oil, importers receive compensation to enable them to buy at world prices and sell at the lower domestic price. (Total payments under the Oil Import Compensation program from 1974 to the end of 1978 have reached $4.8 billion.)

The export price of natural gas rose in 1977 from (CAN) $1.80 per thousand cubic feet (Mcf) to (US) $2.16 per Mcf. Following review in 1978, they were maintained at that level.

TAX INCENTIVES AND THE APPLICATION OF TAX REVENUES

The pricing policy is intended, among other things, to assist the industry in funding exploration activity. It does so directly. Federal and provincial tax rules provide that the industry enjoys a greater share of increased revenues from price rises if it is reinvesting these revenues in exploration activity.

Additional incentives to industry are operated through the instruments of federal income taxation.

1) Arctic and Eastern Offshore Exploration enjoys the additional incentives and high levels of earned depletion for the portion of well costs above $5 million per well.

2) Frontier Exploration also enjoys exemption from payment of the incremental royalty on production resulting from any discoveries made in the frontier regions prior to October 31, 1982.

3) Private investment (by individuals and non-resource companies) in exploration activity is encouraged by

allowing deduction against income from all sources. The April 1978 budget extended this exemption to December 31, 1981.

The total expenditures of the federal government in support of its energy policies (for import compensation, research, conservation and related projects) are financed through tax revenues. In the last few years, total revenues from oil export changes, gasoline taxes and corporate taxes from the oil and gas sector have been very largely committed to support of the national energy strategy.

OWNERSHIP AND CONTROL

A trend to increased Canadian ownership and control of the petroleum industry has emerged over the past six years, in keeping with the targets of Canada's energy strategy. By the close of 1978, Canadians owned an estimated 34,5 per cent of industry assets, up from 24,1 per cent in 1972. Assets under Canadian control climbed to an estimated 24,5 per cent in 1978 from 10,3 per cent in 1972. An accompanying table shows the decline of foreign ownership and control over the period. Figures for the latest year reflect the takeover of Pacific Petroleums by Petro-Canada, the national petroleum company, and acquisition of Husky Oil by Albert Gas Trunk Line Ltd.. Increases for 1976 mark the advent of Petro-Canada while those for 1975 result mainly from the creation of the Alberta Energy Corporation.

The shift to greater Canadian ownership and control over the period was part of a broader structural change reflected in a declining foreign share in equity, sales and profits during the last half of the 1970's.

Analysis of the historical data indicates the following trends:

(1) Concentration has decreased significantly, particlarly since 1970;

(2) The smaller companies, which traditionally spend a far larger proportion of their capital on exploration and development, are maturing into the production stage resulting in an increasing share of production and profits;

(3) Controls upon prices have benefited producers more than refiners and marketers, and gas producers more than oil producers, and these are the areas in which the Canadian-controlled companies tend to concentrate; and,

(4) The advent of several federal and provincial crown corporations.

FOREIGN OWNERSHIP AND CONTROL CANADIAN PETROLEUM INDUSTRY

	ASSETS			EQUITY			SALES			PROFITS		
	$000,000	%NRO*	%NRC*	$000,000	%NRO	%NRC	$000,000	%NRO	%NRC	$000,000	%NRO	%NRC
1970	10331	76.6	91.0	6455	77.8	91.7	5717	77.9	95.5	448	77.9	93.0
1971	11617	77.7	89.6	7351	78.6	90.8	6599	79.5	94.4	606	80.0	93.5
1972	12731	75.9	89.7	7987	76.6	90.7	7703	77.7	93.9	763	77.1	91.8
1973	14570	75.8	87.8	8542	76.1	88.9	9689	78.7	94.0	1082	78.7	93.0
1974	17549	74.0	86.8	9282	74.3	87.9	13734	77.1	93.0	1365	75.9	91.7
1975	20991	72.2	84.7	10914	71.8	85.1	16003	76.1	92.9	1713	75.9	92.3
1976(p)	24785	68.9	80.0	12630	69.6	82.0	18301	75.9	92.3	1777	71.8	83.9
1977(e)	29417	68.4	78.3	14570	69.2	80.5	20204	76.0	90.8	2151	73.0	84.6
1978(e)	33765	65.5	75.5	16250	66.0	76.0	21750	73.0	87.2	2350	69.0	80.0

(p) — Preliminary
(e) — Estimated
*NRO — Non Resident Owned
*NRC — Non Resident Controlled

SOME MAJOR EVENTS OF 1978

WEST PEMBINA, ALBERTA

The major new oil discoveries of 1978 continued to follow the 1977 West Pembina find. Based on analysis of limited current data, ultimate recoverable reserves of oil in the West Pembina area could be 70 million cubic metres. Less conservatively based estimates exceed 150 million cubic metres.

BEAUFORT SEA

Dome Petroleum Limited's drilling program in the Beaufort Sea began in 1976 and has encountered some success, with one possible combined oil and gas discovery and two gas finds being made. Two of the more significant discoveries were recorded during the 1978 drilling season but could not be fully evaluated before Dome had to suspend operations for the year. However, they will be fully tested in 1979 and current plans call for the drilling of three and possibly five more exploratory wells in the same general area.

FOOTHILLS AND DEEP BASIN, ALBERTA

At least 15 significant deeper zone gas discoveries were drilled in the foothills and Deep Basin areas of western Alberta during 1978. Amongst the most important of these were in the Elmworth area of west central Alberta where the original discovery was made in 1976. Since that time more than 50 successful exploratory wells have been drilled.

SCOTIAN SHELF EXPLORATION

During 1978, Petro-Canada continued its exploration and evaluation drilling program on Mobil acreage around Sable Island, utilizing a jack-up drilling unit. Three wells were completed including a successful step-out to the Thebaud wet gas discovery of 1972. Drilling will be suspended here in 1979. Petro-Canada also participated with Chevron Standard Ltd. in the drilling of a well on the continental slope southeast of Halifax in 866 metres of water, the deepest water drilling ever off North America.

LABRADOR OFFSHORE EXPLORATION

Two wells were drilled off Labrador during 1978, one for the Labrador Group of companies operated by Total Eastcan Exploration Ltd. and a second by Petro-Canada in partnership with Chevron Standard. The latter well, off Hopedale, was a significant wet gas discovery, the fourth to be made in this promising frontier exploration theatre. Drilling activity will accelerate in 1979 when as many as 8 units will be operating in the Labrador Sea from Flemish Pass to offshore Baffin Island. Complementary to drilling operations, a three-year, $2.5 million, industry-funded environmental assessment program called OLABS (for Offshore Labrador Biological Studies) was begun during the year, to collect data on marine and coastal living resources preparatory to future development and production of hydrocarbons off Labrador.

NON-CONVENTIONAL CRUDE PETROLEUM: OIL SANDS AND HEAVY OILS

The oil sands and heavy oil resources of Alberta and Saskatchewan are among the world's largest known deposits of petroleum hydrocarbons. As much as 32 billion cubic metres of synthetic crude oil may ultimately be recoverable from these deposits. However, recovery is technologically complex and expensive. The Athabasca oil sands are a mix of dense, black, viscous bitumen of high sulphur content and sand. The heavy oil deposits at Cold Lake, Alberta, are somewhat more fluid than those of the Athabasca type oil sands, but lie within thick loosely consolidated sandstone beds. The Lloydminster, Alberta, heavy oils are of slightly lower viscosity than the Cold Lake deposits.

The upgraded product of these deposits is called synthetic crude oil which is a premium quality refinery feedstock that can be readily refined into a variety of petroleum products.

As world prices for crude oil more than quadrupled over the past five years, and as domestic prices approach them, large-scale development of these resources begins to meet the test of economic feasibility.

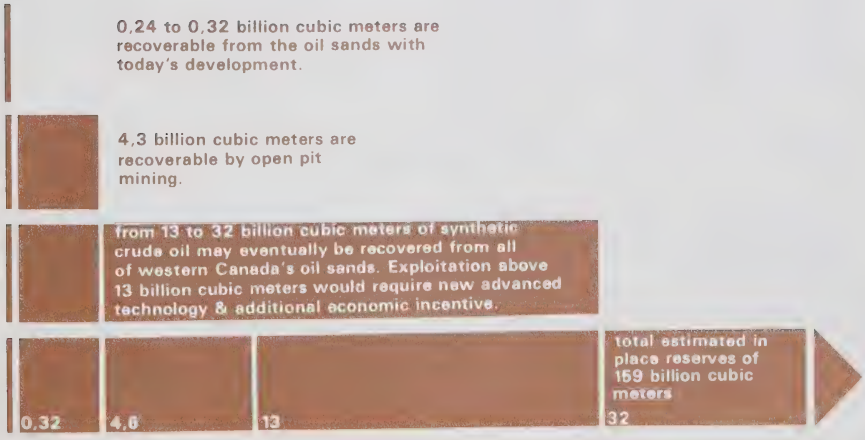
In addition to the federal government's pricing policy, a number of government initiatives are operating to ensure that the petroleum industry is able to prepare now for future full-scale development of the non-conventional crude resources. The federal government, and Alberta, have been major investors in the $2 billion Syncrude plant. Producers of synthetic crude are allowed world prices rather than domestic prices, and the refineries which buy it receive the same compensation that they do when buying imported oil.

The budgets of April and November 1978 contained several measures to accelerate development of non-conventional oil resources: tangible assets for tar sands mining can earn depletion on a special basis for faster write-off against all income, assets for in-situ projects earn a special tertiary recovery incentive; upgrading plants get the same tax treatment as refineries rather than mineral processors, a change that helps oil sand in situ development. Also, oil sands projects call for town sites which obtain real assistance from extension of the depletion allowance to social assets.

Research efforts are funded jointly by the federal and Alberta government and by the federal and Saskatchewan governments and by a further $144 million research program of the Alberta Oil Sands Technology Research Authority.

Synthetic crude oil will play an increasing role in meeting Canadian petroleum requirements. One project, that of Great Canadian Oil Sands, has been operational since 1967, producing approximately 6 400 cubic metres per day of synthetic crude. Further expansion is planned. In 1978, it was joined by the Syncrude project. However, when Syncrude is fully operational in 1981-82 at a production level of 20 000 cubic metres per day, it will only meet about 7 per cent of Canada's daily oil needs.

OIL SANDS



A third oil sands project, the Alsands plant, will also produce almost 20 000 cubic metres per day. The first heavy oil plant at Cold Lake, using in-situ extraction methods, will produce another 23 000 cubic metres per day and the first proposals for Lloydminster facilities envision production of almost 8 000 cubic metres per day. At the close of 1978, all these projects were in the advanced proposal stage, marking the emergence of synthetic crude oil as a critical component in meeting Canada's petroleum requirements.

SOME MAJOR EVENTS OF 1978

SYNCRUDE

Syncrude Canada Ltd.'s oil sands plant came on stream in August 1978. Initial production was 9 540 cubic metres per day and is scheduled to reach 20 000 cubic metres per day when fully operational.

ALSANDS PROJECT GROUP

In early 1978, Shell Canada Ltd. announced a third oil sands project to be undertaken by a consortium of oil companies led by Shell. The project envisions a 20 000 cubic metre per day plant with a twenty-five year life span. Application for required permits is being made to the Alberta Energy Resources Conservation Board (AERCB).

IMPERIAL OIL LTD., COLD LAKE, ALBERTA

In late 1977, Imperial Oil Ltd. applied to the AERCB for approval of a heavy oil recovery and upgrading facility at Cold Lake. Construction could begin in 1981 and be completed by 1986 at a total capital cost over the 25 year operation of some $4 billion. Initially, the facility would produce about 23 000 cubic metres per day of high grade synthetic crude oil.

HUSKY OIL, LLOYDMINSTER, ALBERTA

Husky Oil Ltd. has proposed construction of a heavy oil upgrading facility at Lloydminster with a capacity of 8 000 cubic metres per day.

PETRO-CAN — PACIFIC PETROLEUMS LTD., LLOYDMINSTER, ALBERTA

During 1978 negotiations were conducted between Petro-Canada and a group of other companies headed by Pacific Petroleums Ltd. for the development of extraction and upgrading facilities for the heavy oil reserves in the Lloydminster area, with a proposed production capacity equivalent to that of the Husky Oil project. Petro-Canada acquired a controlling interest in Pacific Petroleums during the year.

TRANSPORTATION

Achieving Canada's goal of self-reliance will depend upon the installation of transportation facilities that will deliver oil and natural gas from western and northern Canadian sources to those areas of Eastern Canada dependent on imported oil. Thus, one of the immediate responses to the OPEC oil embargo of 1973-74 was the extension of the oil pipeline from Sarnia to Montreal for the delivery of Alberta crude oil to refineries that were previously entirely dependent on imported crude oil. Completed in 1977, with a capacity of 52 000 cubic metres per day to Montreal, the line was operating at capacity by the end of 1978.

While the Sarnia to Montreal pipeline has contributed substantially to the reduction of oil imports, the next major and far more significant step towards national self-reliance will be the maximum utilization of Canadian natural gas to supplant imported oil in eastern Canada. Two transportation systems could help meet that objective: one delivering natural gas from Western Canada to points east of Montreal; another delivering natural gas from the Arctic islands to Eastern Canada. Several proposals have been submitted to regulatory agencies, as noted in the review of events below.

Several billions of dollars worth of pipeline and related transportation development activities will proceed over the next few years, including the pipeline for the transmission of Alaskan gas from Prudhoe Bay to the U.S. along the Alaska Highway right-of-way across the Yukon, northern British Columbia and Alberta and south to the U.S.-Canada border, with a provision for a future link along the Dempster Highway to the Mackenzie Delta and Beaufort Sea gas fields. Of the total length of 4 442 Km., 3 362 Km. will pass through Canada.

Another proposed project, known as the Foothills Oil Pipeline, would transmit oil from the Alaskan North Slope to the American Midwest. The oil would be tankered from the south coast of Alaska to the port of Skagway, and then transported by a pipeline across the Yukon to the Alaska Highway and thence along the right-of-way to connect with the existing oil pipeline systems in Northern Alberta.

SOME MAJOR EVENTS OF 1978

In 1978, a clearer picture emerged of future additions to the Canadian network of oil and gas transportation facilities. Important steps were taken towards realizing the Northern Pipeline project and a clear picture emerged of the critical choices respecting alternatives for the delivery of gas to eastern Canada.

NORTHERN PIPELINE

The Government of Canada created the Northern Pipeline Agency (under the authority of the Northern Pipeline Act) for the purpose of planning and administering the implementation of the Northern Pipeline project and specifically for the purpose of considering that its maximum social and economic benefits accrue to Canada and that its attendant social and environmental disruption be minimized. The Hon. Mitchell Sharp was appointed Commissioner of the Agency and its operational headquarters were established in Calgary. By the end of 1978 social and environmental criteria were being developed to constrain the construction of the project and, under the controlling authority of the Agency, the Foothills Pipeline Companies were preparing procurement plans that would meet the standards of maximum Canadian content.

Q AND M PIPELINES LTD.

Q and M Pipe Lines Ltd. has proposed the construction of 3 048 Km. of gas pipeline east from Montreal to Halifax, serving 88 communities in Quebec, 20 in New Brunswick and 22 in Nova Scotia, with the possibility of supplying additional gas for export into the Northeastern U.S. Construction would be scheduled to commence in 1980 with completion during 1982 at a total estimated cost of $950 million.

TRANS CANADA PIPELINE

A second gas pipeline proposal was submitted to the NEB in 1978 by Trans Canada Pipelines. A first phase would extend the Company's existing network from Montreal to Trois Rivieres and Becancour at a cost of $88 million. A second phase would extend the pipeline to Quebec City and points east.

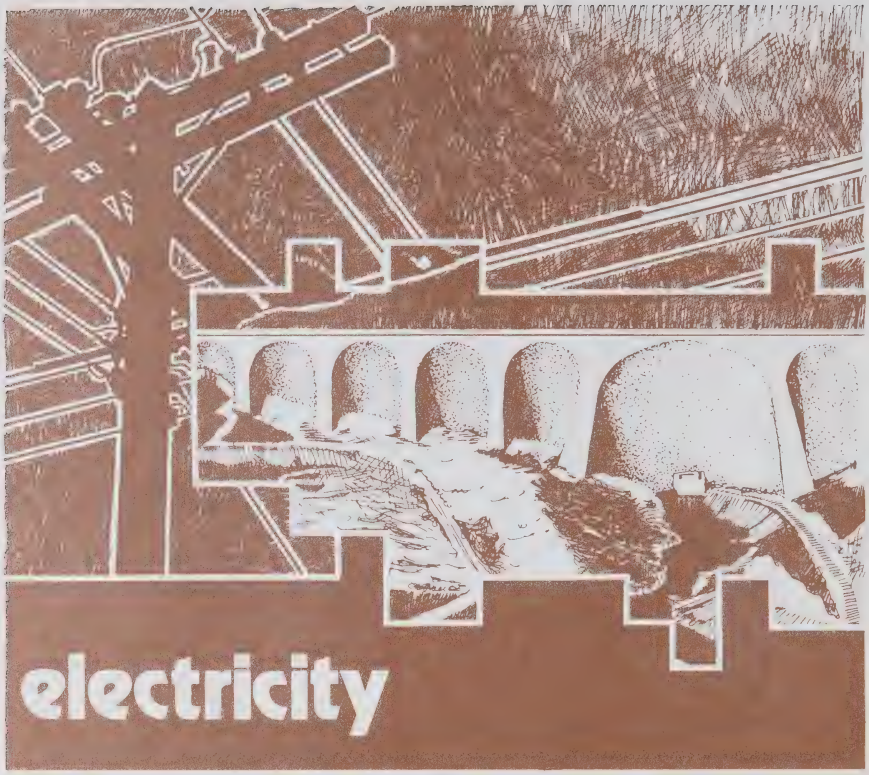
POLAR GAS PIPELINE

The Polar Gas group has applied (originally in 1977) to the NEB to build and operate a natural gas pipeline which would gather gas from the high Arctic islands, transmitting it via a

main pipeline which would run south along the west coast of Hudson Bay to link up with the Trans Canada pipeline in either Manitoba or in Northwestern Ontario. Over 4 000 Km. in length, the total system would cost approximately $7 billion in 1978 dollars. An altenative "Y" proposal was being considered late in 1978 which would bring Mackenzie Delta and Artic Island gas to southern markets. Branches of the line from the Delta and the Islands would meet at Coppermine in the Northwest Territories and a main line would run south to the Trans Canada system.

ARCTIC LNG PROJECT

A second proposal, led by Petro-Canada and Alberta Gas Trunk Line Co. Ltd., would transport Arctic islands gas in liquified form by ice-strengthened LNG tankers from liquefaction facilities in the Arctic Islands to gasification plants on the east coast of Canada. A pilot project has been initiated to construct a barge-mounted liquefaction plant at Drake Point on Melville Island for the production of 71 million cubic metres per day of liquified natural gas for sea transportation by two LNG tankers.



In Canada, electricity not only plays the key role that is required in any modern society, but is of special importance to the pulp and paper, mining, aluminum and chemical industries.

In the long term, as oil and gas supplies decline, electricity will have an increasingly important role in meeting Canada's energy needs.

PRODUCTION

In 1978 Canada's installed capacity to generate electricity increased by an estimated 3 936 MW to 74 153 MW, representing a 5,6 per cent increase. Major projects included those at Nanticoke, Ontario (1000 MW), Long Spruce, Manitoba (372 MW), Sundance, Alberta (375 MW), the Mica Dam in British Columbia (434 MW) and two new nuclear generating stations in Ontario.

Estimated capital expenditure for this generation and related transmission expansion was $6,130 million or an estimated 12,1 per cent of total capital investment in Canada.

ELECTRICITY SUPPLY AND DEMAND*

(billions of kilowatt hours)

	1970	1978
Production	205	336,0
Imports	3	2,2
Domestic Demand	202	314,0
Exports	6	20,7

*ESTIMATE

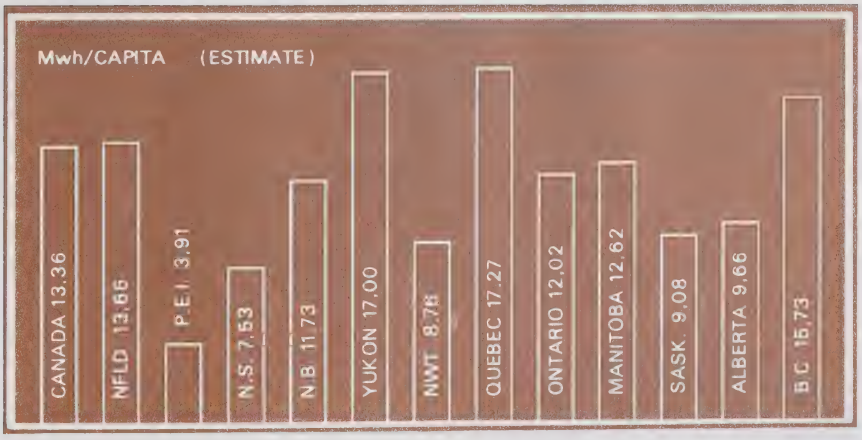
SOURCES

The major source of electrical energy in Canada in 1978 was hydro (70,1 per cent) followed by fossil fuels (21,4 per cent) and nuclear (8,5 per cent).

The following chart shows major existing and planned electrical generating facilities in Canada.

The per capita consumption pattern varies widely from province to province.

ELECTRICITY CONSUMPTION-1978

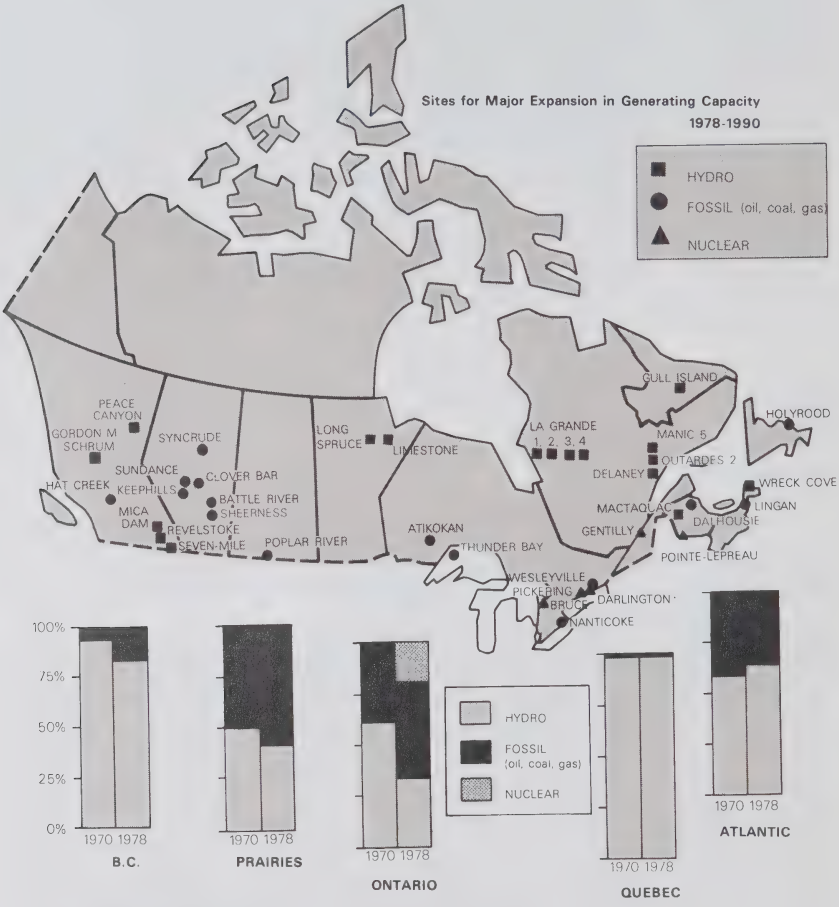


SOME MAJOR EVENTS OF 1978

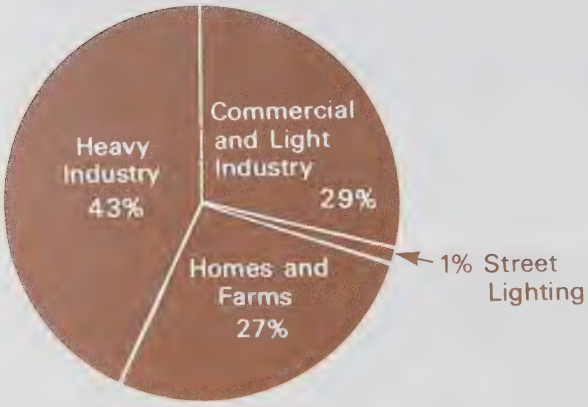
NEW DEVELOPMENTS

The Lower Churchill Development Corporation was established with the signing of an agreement between the federal government and Newfoundland, with the province receiving a majority (51 per

ELECTRICITY IN CANADA 1978-1990



Regional Differences in types of Power Plants Generating Electricity



CANADIAN CONSUMERS OF ELECTRICITY 1978

cent) equity position. The first objectives of this federal/provincial Crown Corporation are to evaluate the Gull Island and Muskrat Falls sites, required transmission facilities, financing, marketing and environmental impact.

Negotiations are proceeding between representatives of Canada, New Brunswick, Prince Edward Island and Nova Scotia on the formation of a Maritime Energy Corporation to coordinate power developments in the Maritimes. When established, this corporation will be responsible for studies of the harnessing of Fundy Tidal energy.

Commercial operation of the Prince Edward Island - New Brunswick cable commenced in 1977. Between January and August 60 per cent of the Island's electricity was imported over the cable from lower cost mainland generation. This $36 million project was developed with a loan of $9 million from Energy, Mines and Resources, and a Department of Regional and Economic Expansion grant of $18 million.

The government of Prince Edward Island has signed an agreement with New Brunswick Power for the long term purchase of 30 megawatts of electrical generating capacity. The sale is designed to avert a projected shortfall of electrical capacity in P.E.I. in the 1980's. The availability and cost of the power will be tied to the Point LePreau generating station, due for commissioning in 1980.

Ontario's Royal Commission on Electric Power Planning, chaired by Dr. Arthur Porter, has submitted its interim report dealing with nuclear power in Ontario. The Commission's debate stage hearings are drawing to a close with discussion of public participation.

RESEARCH AND DEVELOPMENT

The Federal government and B.C. Hydro have agreed to share the cost of constructing a coal-fired, pressurized fluid bed generator. This demonstration unit will be located at Hat Creek, British Columbia.

Federal scientists and engineers are participating in a cooperative R&D program with the Canadian Electrical Association. Federal grants provided for about 40 per cent of the $3.2 million cost in 1978.

A Canada-U.S. study of electrical exchange opportunities is nearing completion with a published report expected early in 1979.

An agreement between the federal government and Newfoundland Labrador Hydro will allow the development of a prototype hydroelectric station for small rivers. It is anticipated that this

type of unit would be suitable for use in as many as fifty Newfoundland communities currently relying on diesel generators for electrical power. Ontario Hydro is also taking an interest in this type of facility, having recently completed the first of a series of 17 small scale hydro-electric stations.

A study of increased interprovincial electrical connections has been completed for the Interprovincial Advisory Council on Energy (IPACE). While numerous interconnections currently exist, this study deals with the development of an interprovincial network implying a unique degree of provincial interdependence.

Canada's coal resources represent an opportunity to help assure Canada's future energy supply. To help reduce the vulnerability associated with dependence on imported oil and imported coal, Canada can increase its consumption of Canadian coal, in the conventional forms in the short term, and for the future in non-conventional (conversion to substitute synthetic fuel) forms.

Currently, coal is used to produce 14 per cent of all electrical power in Canada. This consumed 73 per cent of all the coal used. The steel industry consumed much of the rest for non-energy uses.

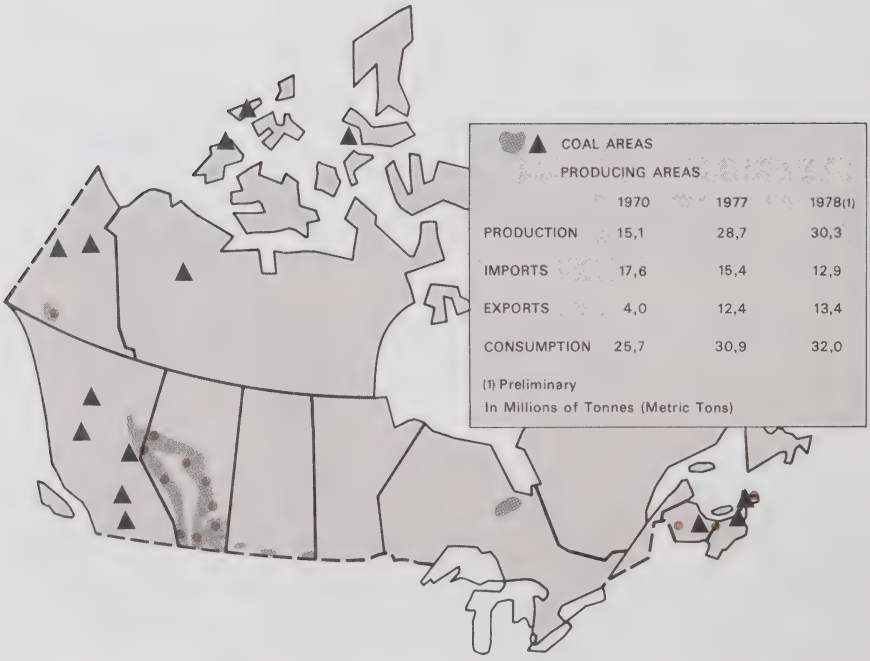
New technology for using coal for electricity generation with better environmental control is being demonstrated in P.E.I. and New Brunswick. The respective demonstration projects are fluid bed combustion and coal/oil slurry firing. Fluid bed combustion relies on the principle of burning coal in an air suspended bed of limestone which reacts with the sulphur in the fuel thereby removing it from the gases during combustion. The combustion

residue is a dry, easy to dispose of mixture of ash and gypsum. Fluid bed combusters offer the advantages of higher thermal efficiencies, lower capital investment, less costly environmental control, and the acceptance of low quality fuels such as coal washery rejects and refuse derived fuels. Coal/oil slurry firing allows the substitution of coal for oil in utility boilers designed to fire oil. It is estimated that this substitution could potentially save Canada approximately $60 million per year in imported oil while increasing employment in the Maritime coal mines.

In addition to electricity generation, coal can be converted to substitute synthetic gaseous and liquid fuels. Coal can supply the thermal requirements of the tar sand and heavy oil plants, thereby increasing the yield of synthetic crude from these facilities. The direct hydrogenation of coal can produce a range of synthetic petroleum products such as fuel oils, transportation fuels and chemical feedstocks. In addition, coal gasification can produce substitute natural gas and synthesis gas which can be used for the manufacture of ammonia, methanol and substitute petroleum products. As the price of the traditional fuels, oil and natural gas, increases, coal conversion to substitute fuels may become economical.

Coal producing areas and the trends in production and consumption during the 1970s are shown below.

COAL IMPORTS AND EXPORTS



	1970	1977	1978(1)
PRODUCTION	15,1	28,7	30,3
IMPORTS	17,6	15,4	12,9
EXPORTS	4,0	12,4	13,4
CONSUMPTION	25,7	30,9	32,0

(1) Preliminary
In Millions of Tonnes (Metric Tons)

PRODUCTION

Canadian coal production rose to 30.3 million tonnes in 1978, an increase of about 2 million tonnes. Fifty mines in five provinces and the Yukon reported production, twenty-nine of these being located in Alberta.

RESERVES

One reason for the increased interest in coal can be found in a comparison of present consumption of coal in relation to recoverable coal reserves and the relation of oil to proven reserves. In 1977 Canadian coal consumption represented .005 per cent of recoverable coal reserves while oil consumption was 8,2 per cent of the proven reserves of conventional crude oil. Coal reserves in Canada are shown below:

Recoverable[1] Coal in Canada — 1976
(millions of short tons "raw coal")

Province and area	Recoverable coal	
	Coking[2]	Thermal[2]
Nova Scotia		
Sydney	54	37
Other	0	0
Sub total	54	37
New Brunswick		
Minto	0	19
Other	0	15
Sub total	0	34
Ontario	0	N/A
Saskatchewan	0	1,896
Alberta		
Plains	0	2,133
Outer Foothills	0	N/A
Inner Foothills	227	N/A
Sub total	227	2,133
British Columbia		
Southeastern	436	N/A
Northeastern	0	0
Other	N/A	1,114
Sub total	436	1,114
Canada total	717	5,214

[1] Recoverable coal refers to the part of a mineable coal deposit that can be delivered at the mine mouth as raw coal prior to further upgrading.

[2] Quality information is based on individual company intentions as to end use.

N/A Feasibility studies either not done or not available to EMR.

IMPORTS AND EXPORTS

Significant amounts of western Canadian coal have been sold to Japan for steel making in the past decade. Coal for the production of electricity in Ontario has been obtained from the U.S. This use of foreign rather than Canadian coal has reflected many factors including: proximity of U.S. coal fields; historical supply relationship; great distances and, until recently, lack of an adequate coal delivery system from western Canada. But an increasing movement of western coal to central Canada is beginning and will reach the 4 million tonne level by the early 1980s.

SOME MAJOR EVENTS OF 1978

FEDERAL APPROVAL FOR NEW COAL MINE IN NOVA SCOTIA

Early in 1978, the federal government announced approval in principle for a 5 year - $265 million plan for new mine developments and rehabilitation of existing mines. Engineering and feasibility studies are to begin immediately with final approval conditional on the outcome of these studies.

NOVA SCOTIA DRILLING PROGRAM

The 1977-78 coal evaluation program funded under a DREE-N.S. agreement was extended to cover work for 1978-79. Evaluation of mainland coal deposits and offshore drilling extended the $5 million drilling program from the previous year.

DISTRIBUTION

Opening of Thunder Bay Coal Terminal.

The new Thunder Bay Coal terminal officially opened in September 1978 completing the final link of an upgraded west-to-east coal transportation system. This new terminal will facilitate the use of western Canadian coal in central Canada thereby contributing to Canada's energy self-reliance. The initial capacity of this facility is 3 million tonnes per year, with the capability of increasing to 6 million tonnes as conditions warrant.

FLUID-BED COMBUSTION PROJECT — DND SUMMERSIDE, P.E.I.

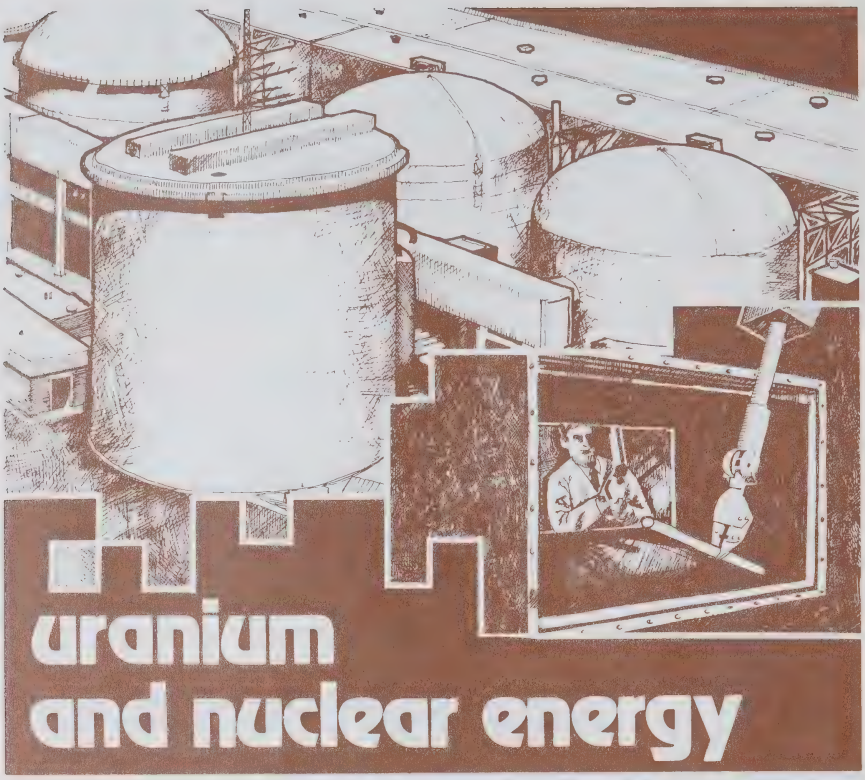
An environmentally acceptable, advanced technology process to convert high sulphur coal and municipal waste to steam/electricity is being applied to the new boiler plant at the DND Summerside base. Two competitive conceptual designs of this new process are complete and negotiations for competitive detailed design are underway. Construction is expected to be complete for the 1980-81 heating season.

FLUID-BED COMBUSTION — CHATHAM, N.B. RETROFIT

Negotiations are underway to retrofit a 16 MWe portion of the Chatham, New Brunswick power plant to allow it to burn high sulphur coal in an environmentally more acceptable fluid-bed mode. It is hoped that the Chatham facility will become a National centre for fluid-bed combustion testing of fuels. The design and construction of the Summerside and Chatham facilities should give Canadian engineering and boiler construction firms an advantage in the expanding fluid-bed boiler field.

COAL LIQUEFACTION

Two tonnes of Alberta subbituminous coal have been sent to Germany for liquefaction yield and economic studies. It is expected that results will be favourable enough to allow a serious exploration of this alternate liquid fuel route.



uranium and nuclear energy

Uranium in Canada has two important roles: as fuel for the generation of electricity in Canada and as an important export commodity.

NUCLEAR ENERGY IN CANADA

Since 1962 nuclear energy has been used to produce electricity in Canada and its importance is growing. Nuclear energy in 1978 is estimated to account for 7,4 per cent of Canada's installed electrical generating capacity. In Ontario nuclear power now makes up nearly 20,7 per cent of that province's electrical generating capacity.

The CANDU reactor uses natural uranium. There are 11 such reactors operating in Canada at this time, 10 in Ontario, and 1 in Quebec. Fourteen are currently under construction: 1 in Quebec, 1 in New Brunswick, and 12 in Ontario. Nuclear generating stations have capacities ranging from 22 MW to 3 000 MW.

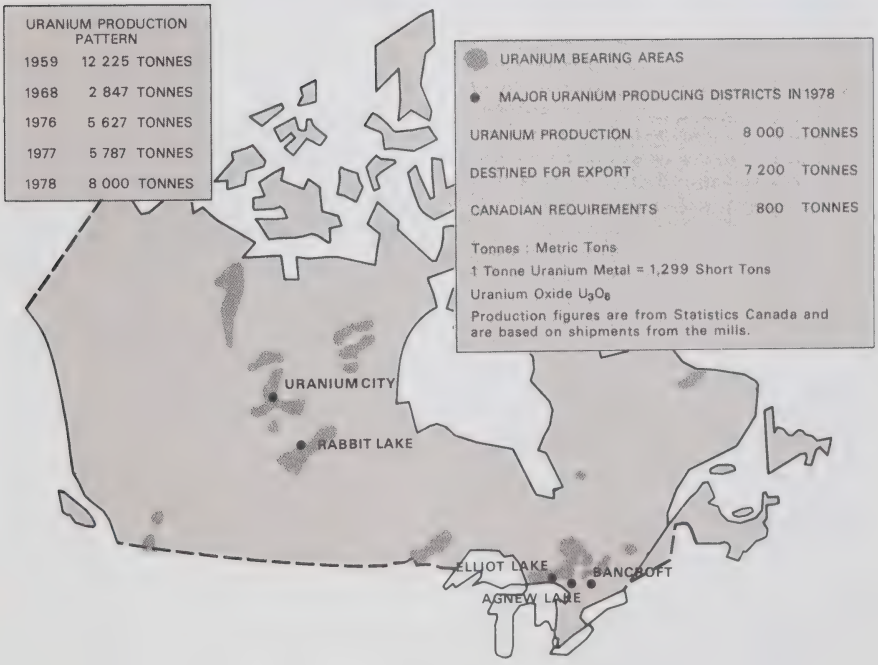
For the existing installed capacity of some 5 520 MW, about 770 tonnes uranium are required each year. The annual demand for uranium from the nuclear plants now operating and those currently under construction will be some 2 000 tonnes per year. Domestic utilities are required to maintain a contracted 15 year forward supply of fuel as part of the federal government's current export guidelines.

Commitments to domestic utilities were significantly increased in early 1978 when the government of Ontario approved long-term contracts for the delivery of some 76 000 tonnes of uranium to Ontario Hydro from two Elliot Lake, Ontario, producers over the period 1980 to 2020. This amounts to a major portion of Canadian needs over this period.

Uranium Production

In 1978 Canada had six uranium producers, operating in five locations. Four are underground operations, one is an open pit mine and the sixth employs an in situ mining leaching technique.

URANIUM PRODUCTION, 1978



Fifty-five per cent of 1978 shipments came from four producers in Ontario, the remainder from two in Saskatchewan.

Production of uranium in 1978 was an estimated 6 800 tonnes of uranium (U)*, compared to 5 794 tonnes uranium in 1977, the increase being attributable to expanded production at all of Canada's six existing producing operations.

Shipments of uranium from production and existing inventory totalled 8 004 tonnes valued at $588 million. In 1977, 5 787 tonnes were shipped with a value of $350 million.

Uranium Exports

Canada's nuclear technology and uranium are important export commodities. Some 90 per cent of all uranium produced in 1978 was destined for export to the U.S., Japan and Western Europe. Canadian production now accounts for 20 per cent of the world output. As of December 1978, total forward export commitments of all Canadian producers were approximately 63 000 tonnes U.

Exports are subject to a number of safeguards to ensure that these resources are used for peaceful purposes only.

Exports to non-nuclear weapon states will be restricted to those countries which ratify the Non-Proliferation Treaty or otherwise accept international safeguards on their entire nuclear program.

Uranium Resources

The Uranium Resource Appraisal Group (URAG) of Energy, Mines and Resources Canada (EMR) published its fourth annual (1977) assessment in June 1978, as summarized in the accompanying table. Resource estimates in all but the measured category increased over those reported a year earlier. The increases amounted to 8,1 per cent, 3,6 per cent and 10,0 per cent for the indicated, inferred and prognosticated categories, respectively; there was no appreciable change in the measured category. Most of the increase was a reflection of continued evaluation work associated with recent exploration successes in Saskatchewan and of encouraging results of exploration programs in several areas of the Northwest Territories.

Early in 1978, the Organization for Economic Co-operation and Development (OECD) released the results of a study showing that

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* 1 metric ton elemental uranium (tonne U) = 1.2999 short tons uranium oxide (U_3O_8)

1977 Estimates of Canada's Mineable Uranium Resources

Resource Category	Mineable at Uranium Prices up to	
	$110/kg U[1]	$160/kg U
	(tonnes U contained in mineable ore)	
(1) Measured	78 000	82 000
(2) Indicated	94 000	107 000
(1) + (2) = Reasonably Assured	172 000	189 000
(3) Inferred	243 000	318 000
(4) Prognosticated	161 000	388 000
(3) + (4) = Estimated Additional	404 000	706 000

Source: "1977 Assessment of Canada's Uranium Supply and Demand"; Report EP78-3, June 1978, Energy, Mines and Resources Canada.

[1]$110/kg U (Canadian dollars) was the estimated uranium market price in September 1977, at the commencement of the assessment.

Canada accounted for some 10 per cent of the non-Communist world's "low-cost" reasonably assured resources, ranking fourth behind Australia, South Africa and the United States. The study also showed that Canada accounts for 31 per cent of estimated additional resources, mineable at costs of up to $ U.S. 130 Kilogram U, and ranks second to the U.S.

Investment

Several major projects are either underway or planned in Canada which will double Canadian output by 1985. Capital costs associated with these projects will total an estimated $1 billion. Three programs of significance are located in the Elliot Lake area of Ontario. Denison Mines Limited has a major expansion underway, part of which ($151 million) will provide for its Ontario Hydro contract. Preston Mines Limited will reactivate its Stanleigh property ($188 million) under its Ontario Hydro contract, and Rio Algom Limited is reactivating its Panel mine and mill ($134 million) to supply its export contracts.

Exploration

Uranium exploration expenditures in Canada continued at a high level in 1978, with activity being reported in all provinces and territories. A survey of uranium exploration activity conducted by Energy, Mines and Resources released in June 1978 reported $72 million in exploration expenditures in 1977, and the 1978 total is expected to exceed this amount. Some 294 000 metres of uranium exploratory drilling were reported by the survey for 1977, more than half of which was carried out in Saskatchewan.

SOME MAJOR EVENTS OF 1978

CLUFF LAKE

Following the release of the Cluff Lake Board of Inquiry's final report favourable to uranium mining in mid-1978, the government of Saskatchewan indicated that the development of the first phase of Amok Ltd.'s Cluff Lake project could proceed. It is expected that the $130 million operation can be in operation by mid-1980 at an initial rate of 1 000 tonnes uranium, increasing eventually to 1 500 tonnes uranium/year. A surface lease agreement was signed in October between Amok and the provincial government, which requires stringent environmental protection measures, health and safety of workers, employment and business opportunities for northerners.

KEY LAKE

At Key Lake, Saskatchewan, Uranerz Exploration and Mining Limited continued with the evaluation of the Gaertner and Deilmann uranium-nickel deposits on behalf of its joint venture partners, Saskatchewan Mining Development Corp. and Eldor Resources Ltd., a wholly-owned subsidiary of Eldorado Nuclear Ltd.

Feasibility studies have indicated that the project, estimated at $200 million, could be in operation as early as 1983, with an annual output of up to 2 300 tonnes uranium.

Sherritt Gordon Mines Limited was engaged to develop an environmentally acceptable process for recovering the uranium and nickel.

BAKER LAKE

In April 1978, the federal Department of Indian Affairs and Northern Development lifted a year-long ban on uranium exploration activity in the Baker Lake area of the Northwest Territories. Land-use permits were subsequently issued to exploration companies subject to restricted utilization of certain areas for specified periods. The restricted areas include land used for caribou migration, calving and post-calving assembly, and critical wildfowl nesting and molting areas. Land used for known caribou water crossings was withdrawn from further use. Since caribou movements can change from year to year, there will be provision for redesignation of critical areas. These restrictions were in line with conditions set out in an interim injunction granted by the Federal Court at the request of the native people in the area. At issue is an aboriginal claim seeking to prevent further uranium exploration activity in a 70 000 square kilometre area around Baker Lake. The case will be heard before the Federal Court early in 1979.

NUCLEAR FUEL WASTE

The report 'The Management of Canada's Nuclear Wastes' by the study group chaired by Dr. Kenneth Hare was examined by the Standing committee on National Resources and Public Works of the House of Commons. In their interim report, they recommended that 'an intensive research and development program into all facets of nuclear waste management be pursued on an urgent basis and that the public be kept informed of the progress of this program'.

An agreement with the Province of Ontario on Radioactive Waste Management was announced on June 5, 1978. This agreement enabled geological field work for verification of the concept of deep underground disposal in igneous rock to be initiated. This first phase of the R&D work is expected to be completed in three years and, if successful, will be followed by selection of a site for a demonstration mine.

OTHER RADIOACTIVE WASTES

The Federal Provincial Task Force on Radioactivity continued their program of locating and reducing radiation readings higher than background (naturally occurring) levels in uranium mining and other communities which had been contaminated due to past practices. At the end of 1978, the overall remedial work was more than 50 per cent complete. New activity in 1978 surrounded the crash of the Russian Cosmos 954 satellite in the Northwest Territories.

As indicated earlier, Cluff Lake Board of Inquiry (Bayda Commission) in Saskatchewan released a report on uranium mining. Part of this report dealt with the question of mine 'tailings' or waste. The major recommendation on this subject was that 'Uranium can be mined and milled at Cluff Lake without serious deleterious effects on the environment but' - further studies were required and the mine operator 'should be required to make such adjustment in its measures as may be necessary to protect the environment'. A further conclusion was that 'if the proper abandonment and reclamation procedures are followed, the long term effects upon the environment may be no greater than those from the ore body from which the material originated, but, nevertheless, surveillance should be planned on a regular long term basis'. The Saskatchewan government announced that Phase I of the Cluff Lake project could proceed, subject to strict occupational, health, safety and environmental regulations.

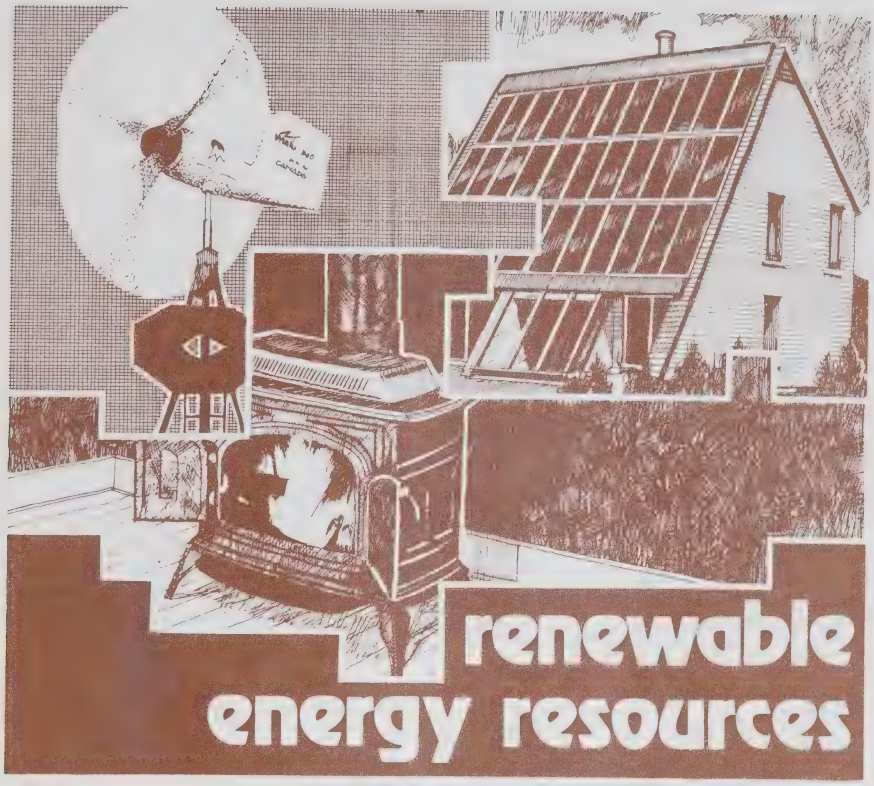
The Ontario Environmental Assessment Board on the expansion of the Elliot Lake uranium mines continued to hold hearings through 1978. They have also taken a particular interest in the long term environmental effects of the mine 'tailings'.

NUCLEAR ENERGY

The 2 000 megawatt Pickering A nuclear generating station in Ontario continued its excellent operating performance with an average production throughout the year of 87,8 per cent of capacity. In addition to the first two units of the Bruce nuclear generating station in Ontario that went into service in 1977, the other two units of the 3 000 megawatt station began operation in 1978. The early good experience with the Bruce A units indicates that the station should perform as well as Pickering A. With all four units in operation, the Bruce A Station is one of the largest operating nuclear electric stations in the world.

The most important stimulus to the Canadian industry in 1978 was the approval by the government of Ontario of two major long-term sales contracts to Ontario Hydro: Denison Mines Limited which will deliver 48 465 tonnes uranium over the period 1980 to 2010, and Preston Mines Limited which will deliver 27 695 tonnes uranium to Ontario Hydro over the period 1984 to 2020. These contracts are the largest sales made to date in the world's uranium industry and will permit uranium operations to continue at Elliot Lake, Ontario, well into the next century.

The government announced in August 1978 that in order to save an expenditure of $150 million in fiscal year 1979-80, it would proceed immediately to negotiate with the Province of Quebec on the mothballing of the LaPrade Heavy Water Plant. It could be brought into service at a later time when its output is needed, perhaps by the late 1980s.



Canada took a major step forward in 1978 toward realizing the important potential of renewable alternatives in Canada's energy future. In July of 1978, the federal government announced that it will spend $380 million between 1978 and 1985 to encourage and support the development by industry of solar and biomass technologies. Both the federal government and provincial governments across the country have committed substantial further funds for research in a variety of renewable areas and for implementation of demonstration projects.

TARGET

The current contribution of renewable energy sources other than hydro electricity to Canada's total energy requirements is modest, and the degree to which these alternatives will one day displace our need for scarce non-renewable reserves remains speculative. However, a clearer picture is beginning to emerge of the potential value that will be returned to the Canadian economy from the heightened level of governmental and industrial

interest, and some estimates indicate that by the year 2000, biomass and other alternative energy resources could contribute the equivalent of 10 per cent of our total energy.

Biomass

Biomass energy is the energy value of plant and animal matter, released through either biological or chemical conversions, such as direct combustion. Some of the potential energy value to be drawn from Canada's vast wealth of forests and agricultural waste can be realized in the near-term future.

Currently about 3,5 per cent of Canada's primary energy is supplied by the combustion of wood. This could be doubled by the forestry industry alone, if it achieves its short-range goal of replacing 60 per cent of its oil and gas consumption by combustion of its waste products. As the single largest consumer of petroleum products in Canada, the annual savings would exceed 30 million barrels at current consumption rates.

In the longer term, another 100 million barrels of oil per year could be saved by harvesting the branches, tree-tops and other slash now left in the forests.

Solar

While solar energy has not yet established itself as a viable alternative under current economic circumstances, it is forecast by some experts that solar energy will be the economic choice in domestic water heating and space heating in new multiple and single-family dwellings within a decade. Equally promising are applications to industrial processes requiring large quantities of hot water at low temperatures: film processing, laundries, food processing.

The current problem, however, is that the present capital cost of the equipment, even calculated over the life of the solar installation, is generally greater than that of conventional fuel systems. However, conventional fuel costs will continue to rise, and the real costs of solar systems will decrease with improved design, operational efficiency and production techniques. Under these circumstances, certain to emerge by the mid-eighties, the solar alternative will achieve economic viability.

Geothermal

There is considerable potential in Canada for geothermal energy, drawing hot water from the Rocky Mountains or the deep sedimentary basins of the Prairies and western Arctic. The economic significance of these resources is uncertain and its

realization a long-term prospect, particularly where the energy source is remote from centres of population and industrial activity.

The future potential of this energy source merits further research and development. In 1978, the federal government committed $750,000 to the University of Regina in Saskatchewan to conduct the first phase of a project to demonstrate use of geothermal energy to heat a large building.

Wind

Like geothermal energy, the efficient and economically viable use of wind as an energy source is a matter of active interest and long-term potential significance to Canadians. In fact, Canada has developed some of the world's most advanced windmill technology.

There are, however, constraints. Intermittent supply must be overcome by either storage of energy or linkage to economically and technically compatible supplementary systems. Wind power comes in small units which are not suitable for major concentrations of population.

Tidal Power

Canada has long looked to the great tides of the Bay of Fundy as a potential source of hydro-electric power for the Maritime provinces. The report of the Tidal Power Review Board was presented to the governments of Canada, New Brunswick and Nova Scotia in 1978. While it recognizes that full scale development of tidal power is still not competitive with conventional energy sources, it recommends a preferred site in the Cumberland Basin, and a three-year pre-feasibility research and evaluation process costing $33 million. The federal government has accepted these recommendations in principle.

SOME MAJOR EVENTS OF 1978

On July 4, 1978, the Hon. Alastair Gillespie, Minister of Energy, Mines and Resources, announced a series of programs to stimulate the wider adoption in Canada of renewable and conservation technologies. Major elements of this significant initiative, are as follows:

FOREST INDUSTRY RENEWABLE ENERGY PROGRAM (FIRE)

More than $100 million for the forest industry to use wood wastes efficiently as an energy source, between 1978 and 1985. Under the program, taxable payments of up to 20 per cent of approved capital costs will be provided.

BIOMASS ENERGY LOAN GUARANTEES

Federal government guarantees for loans, worth a total of $150 million to assist in establishing electrical generating facilities using biomass as the energy source. This approach will encourage groups of industries, perhaps in cooperation with nearby communities and provincial electrical utilities, to combine efforts on a local level to use wastes for electrical generation. Terms of the program will especially encourage cogeneration of electricity and heat.

EXPANDED RESEARCH, DEVELOPMENT AND DEMONSTRATION FOR FOREST BIOMASS ENERGY (ENFOR)

Approximately $40 million will be available from the Federal Government between 1978 and 1984 to help fund research projects and demonstrations of innovative techniques such as biomass plantations and the conversion of biomass to liquid fuels or chemicals.

PURCHASE AND USE OF SOLAR HEATING PROGRAM (PUSH)

$125 million will be available between 1979 and 1984 for the preferential purchase of Canadian-made solar space and water heating equipment for federal buildings. A large new market will open up but, within five years, the subsidy component will be phased out, and solar equipment will be expected to compete on an equal footing with other types of systems.

PROGRAM OF ASSISTANCE TO SOLAR ENERGY MANUFACTURERS (PASEM)

This program is in two phases. Twenty-four grants of $10,000 have been awarded to firms to prepare solar equipment design proposals. In the second phase the Federal Government would make up to 10 contributions, of $200,000 to $300,000 each, to assist Canadian firms to design and develop solar heating equipment to meet the requirements of the PUSH program.

FEDERAL-PROVINCIAL DEMONSTRATION AGREEMENTS

The federal government has allocated $114 million to be spent between 1979 and 1985 under cost-sharing arrangements with provinces and the private sector for the demonstration of novel technologies in renewable energy and conservation.

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GLOSSARY

Atomic or nuclear energy: All energy of whatever type derived from or created by the transmutation of atoms. See CANDU, and nuclear wastes.

Biomass: Unfossilized material of biological origin. Organic compounds which are embodied in biological materials and produced by living organisms, for example, wood, other vegetation and animal excrement.

CANDU: The Canadian nuclear reactor system which is moderated by heavy water (deuterium) and is fuelled by natural uranium. The name is derived from CANada, Deuterium and Uranium.

City-gate price: The unit price charged by the transmission company for natural gas transported via pipeline to a distribution company in a particular city or area, e.g. Toronto.

Coking coal: Coal which meets specific processibility criteria and which has sufficiently low contaminants for the production of metallurgical coke, essential to the manufacture of steel.

Co-generation: The generation of electricity by increasing the temperature and/or pressure of heat required for process use, extracting part of the heat for electricity production and discharging the remainder at appropriate conditions for process requirements.

Conventional oil: Crude oil recoverable from a well using standard production techniques. See recovery methods.

Crude oil: Petroleum which enters the refinery, subject to quality grading and commensurate price variations.

Demonstration: Technologies, equipment and methods which have reached a threshold of operational reliability that indicates commercial feasibility.

District heating: The supply of heat in the form of steam or hot water to a group of buildings from a central source, such as a dedicated thermal plant, or from co-production, co-generation or recycled or reject heat sources, for example, from industrial processes.

Fission/fusion: Fission is the splitting of atomic nuclei and fusion is the combination of two atomic nuclei. In both processes the mass yielded is less than the respective masses of the original nuclei. The lost mass is given off as energy.

Fluidized bed combustion: A process in which combustible materials are introduced into a greater volume of hot inert particles, contained in a chamber and maintained in a state of turbulence by a stream of gas (air) from below during their thermal conversion. The process can be pressurized.

Frontier areas: Generally the undeveloped northern mainland, the offshore areas (east, west and Hudson Bay), the Arctic Islands (onshore and surrounding offshore) and the Mackenzie Delta-Beaufort Sea.

Forest biomass: Biomass derived from forest matter. Residues from forest harvesting and from pulp and paper and wood products industries; also wood harvested specifically as an energy source, possibly from plantations of rapid-growth species dedicated for energy production.

Fossil fuels: Any naturally occurring solid, liquid or gaseous fuel of a fossilized organic nature. See hydrocarbons, resource, reserve.

Fuel: Any combustible materials which give off heat; also materials which can be fissionized in a chain reaction to produce heat (atomic or nuclear energy).

Geothermal energy: Energy from natural "hot spots" in the earth's crust; associated with hot dry rock or large reservoirs of steam or hot water.

Heavy crude oil: Oil which is of high viscosity recoverable only to a limited extent (5 per cent) from the reservoir by using standard production techniques. (See recovery methods and synthetic crude oil.)

Hydrocarbons: Organic compounds containing only carbon and hydrogen atoms in various molecular configurations. Those which occur naturally as fossil fuels include conventional light crude oil, heavy oils, oil sands bitumen, natural gas liquids, natural gas and coal.

In situ: Literally means "in place" and refers to recovery techniques applicable in heavy oil and oil sands without removing conglomerates from location. See recovery methods.

Low-grade (or low-temperature) heat: Heat which does not exceed 100°C (212°F).

LNG: Liquefied natural gas; natural gas which is cooled and maintained at -160°C as a liquid, reduced in volume nearly 600-fold; when shipped by tanker transport, it is typically vaporized at the receiving terminal for pipeline transport and use.

LPG: Liquefied petroleum gases -- propanes, butanes and propane-butane mixes which are a by-product of crude oil and natural gas production, and of refinery operations. LPG's can be regarded as a subset of the natural gas liquids (NGL's).

Metallurgical coke: Derived from coking coal for purposes of processing metals (see coking coal).

Methane: CH_4 formed by the decomposition of organic matter (e.g. deep coal deposits). Methane is the major constituent of natural gas. See SNG.

Methanol: CH_3OH formed either synthetically or from the destructive distillation of wood. A light, flammable, poisonous liquid alcohol which can be used as fuel, for example, internal combustion engines; or blended with gasoline.

Natural gas: Naturally occurring mixtures of hydrocarbon gases and vapours; mostly methane (CH_4).

Natural gas liquids (NGL): The complete range of volatile liquid hydrocarbons associated with production and refining of oil and production of natural gas. Includes LPG's.

Nuclear wastes: Radioactive products of the nuclear fuel system; e.g. irradiated fuel (bundles) and reactor wastes which have accumulated in filters, or other devices and materials associated with operating and maintenance activities.

Nuclear waste management: Systems to use or dispose of nuclear wastes to eliminate or substantially reduce the risk of injury to the health of living organisms. Nuclear waste management involves:

- immobilization - encasing the radioactive products within a solid protective material (glass, ceramic, bitumen or metal) to protect against dissolution by water;
- storage - emplacement of radioactive material in a safe location with the intention of retrieving it;
- disposal - permanent placement of radioactive material with no intention of retrieving it;
- repository - an engineered site designed for disposal of radioactive material.

Oil sands (tar sands): Deposits of sands and clay (excludes oil shale) heavily impregnated with hydrocarbon compounds known as oil sands bitumen which does not flow.

Petroleum refining: The separation of the different petroleum (crude oil) hydrocarbons into groups and their conversion into marketable products. It includes processes for increasing the yield of desired hydrocarbons and methods for purifying the resultant products.

Primary energy is the available energy content of the natural resource. Secondary energy is the amount of energy delivered to the final consumer. The difference between the two is the energy lost in conversion and in the process of supply. It should be noted that during the final end-use process additional losses occur at the point of final use.

Recovery methods: Various technologies for the production of petroleum (crude oil) from oil reservoirs, depending on the viscosity of the oil, the type of geological formation and the depth and natural pressures at which the recovery operations are applied. Recovery methods are categorized as either primary or enhanced. Primary recovery is the standard oil well production technique and yields approximately 20 per cent of conventional light crude oil but only 5 per cent of heavy crude oil from a reservoir, using natural pressure augmented by wellhead pumps. Enhanced recovery methods include secondary and tertiary techniques which increase the proportion of oil recovered, but at additional recovery costs. Water flooding is the best known secondary recovery technique, serving to supplement the natural pressures; yields up to 80 per cent of conventional crude oil and approximately 10 per cent of heavy crude oil from a reservoir. Water is pumped down "injection" wells forcing oil up through "producing" wells. High-pressure live steam (tertiary recovery) similarly injected will increase the heavy crude oil yield to approximately 20-40 per cent by reducing the viscosity and forcing greater volumes from the geological network into the producing wells. Steam stimulation is at the commercial threshold as a tertiary, "in situ" recovery technique for heavy crude oils in western Canada. Wet combustion or fire-flooding techniques applicable to heavy crude oil reservoirs and deep oil sand deposits (over 1 000 feet depth) are presently at developmental stages, but at much higher cost. Fire-flooding requires the injection of air or oxygen to induce controlled combustion in the reservoir area, thereby increasing the temperature and lowering the viscosity of the heavy oils to facilitate recovery by pumping.

Renewables: Energy sources which are perpetual or replenishable; have life spans comparable to that of the solar system. Solar, biomass, geothermal, wind and hydraulic-river, ocean tides and waves are examples.

Reserve: That portion of an identified fossil fuel resource from which a usable energy commodity can be economically and legally extracted at the time of determination, using currently available technologies.

Reservoir: Here refers to a site-specific part of an oil or natural gas reserve at which recovery operations are applied.

Resource: All potential energy-producing natural phenomena and accumulations of naturally occurring substances which are known or inferred to exist (e.g. oil, natural gas, coal, uranium, hydraulic, peat and forest biomass).

Retrofit: Adding to a unit a device or materials of the purpose of enhancing the functional performance of the original unit.

Slurry: A free-flowing pumpable suspension of fine solid material in a liquid. A slurry pipeline is one method of transporting coal.

SNG: Synthetic (or substitute) natural gas producible from maphtha, coal and biomass. Contains mostly methane.

Synthetic crude oil: The oil product obtained from upgrading (cracking) oil sands bitumen and heavy crude oils.

Solar energy: Energy in the form of solar radiation.

Thermal coal: Coal burned to produce heat, for example, for electrical generation and industrial processes; it will yield gaseous fuels by gasification processes and liquid fuels by liquefaction processes.

Wellhead: The location of primary extraction, usually of oil and natural gas. Also refers to the equipment used to maintain surface control of an oil or natural gas well and to various parameters as they exist at the wellhead, e.g. "wellhead price" applicable to natural gas and conventional crude oil production.

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